

The Blast Furnace *and* Steel Plant

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Always the Friend of Industry



—Courtesy of Iron Trade Review.

We like to think of Warren Harding as a friend just left—not as a President claimed by untimely death.

His smile of comradeship was an inspiration.

Observe him here surrounded by the members of a safety crew, whom he delighted in congratulating for expertness in performance of their duties.

Wherever men worked, there Harding liked to be. Always keenly alive to the value of first hand information, he welcomed an opportunity to KNOW the atmosphere of industry.

The steel industry believed in him, and has proven its faith by setting in motion all the conflicting forces which the "shorter day" involves. There could be erected no more fitting living memorial than the carrying out today of this plan toward which he had worked so hard and so successfully.

Electricity's Relation to Steel

A Glance Backward Suggests a Glowing Forward Prospect

By JOHN F. KELLY*

CHARLES M. SCHWAB once said that an idea that could survive the test of the cold, grey dawn was one which would live, and when a steel mill electrical engineer in an after-dinner speech proposed that the guests commit themselves to the application of electricity to the iron and steel industry, neither he nor the engineers with him ever dreamed of the possibilities that the future held for him or them.

What does the future hold forth for the electrical engineer? The possibilities are as limitless as the sands in the desert. Let us stop just for a moment and go over in our minds the number of men who have made the grade. Alva C. Dinkey, president of the Midvale Steel and Ordnance Company, began his executive career as electrical superintendent of Homestead Steel Works. Later general superintendent of these important units,



JOHN F. KELLY

Mr. Dinkey's acknowledged ability to think in terms of electrical energy, not less than his personal human contact and co-operative spirit have earned him fame as one of the most constructive forces in the entire steel industry.

Forty years ago an unknown foreigner stepped on our shores alone unnoticed. He had no friends to welcome him, encourage him and boost him—he needed none. Dr. C. P. Steinmetz, today, the greatest electrical wizard on this or any other continent, the genius with the million-volt mind.

Frank Conrad, whose start in life as an errand boy gave little augury of his future, is today one of the brainiest electrical engineers to be found among the ranks of America's great electrical companies.

And we might enumerate indefinitely.

When, as a boy working in the mills of one of the

*Secretary, A. I. & S. E. E., Pittsburgh, Pa.

largest pipe concerns, I marveled at the mystery of electricity. Looking down into a pit, watching and listening to the hum and whirl of two small d.c. generators, the energy of which was used imperfectly for lighting purposes around the mill, I wondered why and where it came from, what it was,—this strange inscrutable force which seemed pleased to do our bidding. Today,—25 years later, after intimate contact and exhausting research, by countless minds—the why or where is still a mystery; this energy is more flexible in its application to human needs and better subjected to man's control,—the rest is still conjecture. Steinmetz, the wizard of electricity, who has perhaps accomplished more than any other man in history with this mysterious power, even though an intellectual giant, and able to diagnose the action of lighting by staggering feats of mental and mechanical ingenuity, knows not why or where. Even he still wonders at this force. He may hurl thunder bolts, which leap about in his lightning arsenal, working destruction. He may play with millions of volts, millions of horsepower, but still he is merely the director, not the master.

To picture the future of the electrical engineer in the vast steel industry is therefore a difficult visualization. We know that the marvelous advances made in the past few years are but infant steps on the threshold of greater mansions. We know that seeming impossibilities have become achievements. We know that man has found an ally,—an all powerful force destined to solve not only the problems of industrials,—but the problems of mankind in its human relations as well.

It is possible today to go into the steel mills, and find the hot metal flying through the air, making almost impossible twists and turns, which eventually fashions itself into the finished product, and yet all these wonders are accomplished without the human element, all automatic, all magnetic, all due to the unseen, unknown power, called electricity.

Not long ago I listened to Dr. John Unger portray a wonderful word picture of the future steel industry, but to my mind he did not go far enough. The future and modern steel plant will consist first of an electric furnace, which will produce steel direct from ore. The rolling and finishing mills will be entirely free from the human element all of which will be controlled from a master switch in the executive's office. There will be no dirt, no grease, no grime, no smoke, no worry;—economical and enormous productions, all due to the electrical geniuses of today and tomorrow.

At Buffalo, in September, at the Broadway Auditorium, will be assembled over a million dollars' worth of electrical apparatus, which will represent the latest developments in the electrical arts. Over 150 of the largest manufacturers in the United States will demonstrate, not their models, but with production machinery, how the results may be attained that every engineer is striving for—the conservation of fuel, economical production, the preservation and safeguarding of mankind.

The Association of Iron and Steel Electrical Engineers, through the Blast Furnace and Steel Plant, invite you to attend their Iron and Steel Exposition, being held in Buffalo, New York, at the Buffalo Auditorium.

A. I. & S. E. E. Annual Convention

Many Well Known and Authoritative Speakers Will Make This a
Memorable Gathering—Electric Foundry a Novel Feature

On this and the following pages will be found a program of the notable papers which are to be presented before the convention. No attempt at a digest of the contents has been made, merely a hint as to the author's purpose.

High Pressure Steam Boilers

By Dr. D. S. Jacobus

Advisory Engineer, Babcock & Wilcox Company
New York City

More than any other single individual, Dr. Jacobus may be called the "Father of Modern Steam Generators." His work in his chosen field has been fundamental and authoritative.

As a writer on the subject of steam generators, no author carries such a responsive following. Never swayed by ingenious departures from standard practices,—he nevertheless is keenly alive to whatever is best for progress and reliability.

The safety crusaders owe Dr. Jacobus a debt of gratitude.

In conclusion, he says:

"There is but little gain in the economy in increasing the steam pressure to a higher point than 350 lbs. per

expense, and the possible difficulties in operation due to the additional complications have an important bearing on the use of higher steam pressures."

The Liquid Slip-Regulator or Rheostat

By D. M. Petty

Electrical Superintendent, Bethlehem Steel Company
Bethlehem, Pa.

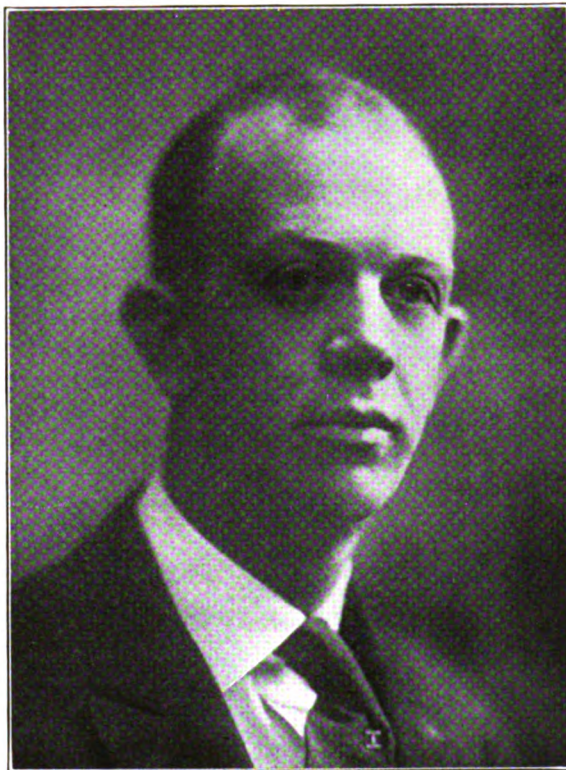
"The purpose of this discussion is not to cover the operation of liquid rheostats but rather to bring out some comparative points in a few of the various types that have been designed and put in service."

Mr. Petty requires no introduction to readers of Blast Furnace and Steel Plant. His recent description of



DR. D. S. JACOBUS

sq. in. *without interstage heating* of the steam, that is, the steam from one stage of the turbine must be withdrawn from the turbine, resuperheated and returned to the following stage of the turbine. Interstage heating necessarily involves additional complication and added



D. M. PETTY

the Electrical Applications in Bethlehem Steel,—which, in collaboration with Mr. Standing, electrical engineer of Lehigh Division, appeared in June and July of this year. In October, 1922, issue, his paper on "Internal Combustion Engines for Power Generation in Steel Plants" appeared.

Mr. Petty is a past president of the A. I. S. E. E.

As chairman of the special Committee on Bearings, Mr. Petty will deliver the committee's report on that subject.

Electric Furnace Phenomena

By E. T. Moore

Electrical Superintendent, Halcomb Steel Company
Syracuse, N. Y.

Mr. Moore is a close student of electric furnace developments, and has been a prolific writer on the subject.

The February issue of Blast Furnace and Steel Plant contained a review of electric furnace tendencies by Mr. Moore, this work by him being an annual contribution.



E. T. MOORE

His recent development work in current controls has done much to improve load factor in electric furnace operation.

"The annual report of the Electric Furnace Committee for 1920 discussed operating details of electric arc furnaces, so when plans were made by the committee for the 1921 report it was decided to outline the details of an elaborate series of tests covering the coalition of operating data and in addition carry on research work along the following lines:

1. A thorough study of the heat losses from electric furnaces.
2. Presentation of operating data on furnace electrodes according to the electrode specifications drawn up by this committee and presented in the 1920 report.
3. An investigation of the merits of dual voltages, and the deleterious effect on the metal, if any, of a relatively high voltage for melting.
4. Investigation of electric furnace phenomena."

The Tempering of Coal

By Thomas A. Marsh

Chief Engineer, Green Engineering Company
Chicago, Ill.

"The subject of tempering of coal deserves careful consideration and analysis for the reason that in some

sections of the country the practice of adding water to coal is quite prevalent, and results, as reported from plant operators and as reported on tests, indicate definite advantages for the practice."

Tests show that:

- (a) Properly tempered coal has less resistance than either very wet or very dry coal.
- (b) Very wet has less resistance to air flow than very dry coal.
- (c) Moisture added to coal is largely surface moisture and does not penetrate deeply.
- (d) Particles of coal do not "burst open," due to internal steam formation.

The author cautions those tempering coal to analyze their conditions, as adding moisture to coal can easily be overdone to a disadvantage. There is no merit in mois-



THOMAS A. MARSH

ture dripping from coal. Much of this investigation has been made on traveling grates,—the territory of which is with western fuels,—but Iowa coals fired on underfeed stokers reported improved results from tempering.

Boiler Troubles from the Operating Man's Standpoint

By Carl J. Smith

Fuel Engineer, Inland Steel Company
Indiana Harbor, Ind.

"It is the intention to deal with troubles encountered in the operation and maintenance of steel mill boilers, as no doubt the troubles encountered are more numerous than with boilers in any other service, due to the absence of any well-defined load curve, the absence of any consid-

erable amount of condensate return, and a large labor turnover in the operating force."

Carl Smith is a newcomer into the ranks of publicists, but not in the ranks of operating engineers.

His title represents the man.

Mr. Smith knows from practical experience just what boiler troubles are, or may be, and his constant aim



CARL J. SMITH

has been an analysis of these problems and their reduction to a constructive remedial basis.

The Inland Steel plant represents much that is best in recent power progress, and developments now in process of installation will carry considerable interest among steel mill power practices.

The Complete Electrification of the Foundry Industry

By Leonard W. Egan

Consulting Engineer, Cleveland, Ohio

"The subject of electrification of the foundry is one that entails more than the mere selecting and installing of motors, controllers, wiring, etc., as is the case in the foundries today. It covers the maintenance of the entire plant equipment and its production of and continued uninterrupted service. It is inseparably linked with the design and application of all equipment and the manner that it enters into foundry production."

"The discussion has been divided into eight general subjects:

1. Electric molding machines, roll-over, pattern draw machines, sand slingers.
2. Sand-handling systems.
3. Electric furnaces: (a) melting furnaces for non-ferrous metal (b) Core ovens.
4. Cranes.

5. Purchased power.
6. Electric welding.
7. Safety.
8. Air and electric hoists.

This is one of the most comprehensive and exhaustive papers given before this society, and well merits the attention it will undoubtedly be given. The subject is of vast importance.

Surface Combustion and Its Application

By W. M. Hepburn

Vice President Surface Combustion Company
New York City

"The highest temperature attained in the combustion of a gaseous fuel, the so-called flame temperature, for any given inlet temperatures of the air or gas depends chiefly upon the quantity of air supplied, the intimacy of the mixture of the air and gas and the amount of heat dissipated during the period of combustion. In order to eliminate any ambiguity, combustion may be defined as the chemical union of substances taking place at a temperature above their combining or ignition point and with sufficient energy to develop heat, flame as a gaseous mass in the process of combustion."

"One of the chief causes of low furnace efficiency with the average furnace design is the lack of provisions for protecting the burning gases from dilution with the inert flue gases before the combustion has been completed. This, at the best, materially retards combustion and there-



W. M. HEPBURN

by lowers the combustion temperatures and increases the flue gas temperatures."

"In conclusion, it may be said that the intention of the preceding discourse is not to attempt to explain in the terms of the original surface combustion the various applications of gas combustion which have just been mentioned but to point out the effects of each particular principle now being utilized."

Systematizing the Work of an Electrical Engineering Division

By P. T. Vanderwaart

Electrical Engineer, New Jersey Zinc Company
Palmerton, Pa.

"In the records of this association and elsewhere, there are many good articles describing efficient systems for the important work of maintenance, cost-keeping and material handling. No matter whether the organization



P. T. VANDEWAART

be large or small, the work first mentioned is also very important, and the following of a carefully planned system will result in a considerable saving of effort and equipment, which means reduced operating and capital costs."

"The forms presented in this paper are the result of experiments and observations during several years' work with industrial plants and public utilities."

Single Bucket Blast Furnace Skip-Hoist Characteristics

By A. C. Cummins, Electrical Superintendent, and
A. R. Leavitt, Elec. Eng. Dept.

Carnegie Steel Company, Duquesne, Pa.

"Single bucket blast furnace skip hoists are customarily equipped with one of three different types of electrical apparatus. A fourth type has recently been suggested,—the so-called variable voltage, or Ward-Leonard system. This system, while never used for blast furnace hoists, has been successfully employed for elevator service. The four available types of equipment are as follows:

1. Single motor d.c. drive.
2. Double motor d.c. drive.

3. Single motor a.c. drive.

4. Ward-Leonard using either a. c. or d. c.

Each design has certain claims for superiority, and in making a selection as to correct type for a given hoisting problem, the engineer must carefully weigh the advantageous features.

It is the purpose of this paper to call attention to the features claimed for each type, and to present test data secured while checking over the actual performance of a number of hoists."

Motor Operated Centrifugal Pumps in Steel Plants

By B. A. Cornwell

Electrical Engineer, Carnegie Steel Company
Youngstown, Ohio

"In the steel industry, one of the most important factors in maintaining and increasing production is the efficiency and the reliability of the water supply system, which we feel should be electrically driven."

"Centrifugal pumps are especially suited for handling large quantities of water quickly, and this type of



B. A. CORNWELL

pump has been adapted for supplying water under low heads for blast furnaces, condensers, cooling-water systems, etc."

The performance and operation of typical centrifugal pumps can be seen by referring to characteristic curves shown.

The cost of pumping 1,000 gallons of water per hour by motor-driven centrifugal pump, \$.00238, compared with \$.00288, where turbine-driven centrifugals are in service.

Electric Transportation

By F. O. Schnure

Electrical Engineer, Bethlehem Steel Company
Sparrows Point, Md.

"Yard transportation within a steel plant, probably represents the largest variety, if not the most severe work, of any industrial haulage. Yard electrification as a factor in bringing lower haulage costs should be of prime im-



F. O. SCHNURE

portance to the industry. It is therefore the duty of the Iron and Steel Electrical Engineer in considering the proposition to apply the experience gained in mill electrification, in the selection of locomotives, motors, controls and collector systems."

"Steel mill engineers should be looking forward to the day when the only stacks belching smoke will be those attending the power station."

A System of Coal and Ore Bridge Traverse Control for Protection Against Wind and Skewage Hazards

By P. R. Canney

Electrical Engineer, Minnesota Steel Company
Duluth, Minn.

"The hazards to movable bridges may be divided into two general classes: Those prevalent when the bridge is stationary and those to which it is subject while in motion. Before discussing the control system, it will be well to consider the causes of some of the hazards."

These hazards fall in five sub-divisions:

1. Wind thrust in severe storms.
2. Dangerous track conditions.
3. Failure or breakage of mechanical details.
4. Mistaken or carelessness of operation.
5. Unsuitable or deficient control equipment

"The installation of a recording or indicating anemometer on each bridge, with the instrument right at the operators bridge traversing controllers is a most important safeguard."

General Specifications for Construction and Installation of Automatic Engine Stops, as Recommended by Safety Committee

By Walter Greenwood, Chairman

Safety Engineer, Carnegie Steel Company
Youngstown, Ohio

Whenever Mr. Greenwood speaks everybody listens. He has made "Safety" his watchword, and no man in the steel industry lives nearer his ideal.

Whenever a careful investigation on the most difficult of safety problems is demanded, Walter Greenwood



WALTER GREENWOOD

will be found on that Carnegie committee,—and his committee report can be relied upon to have found the "nigger in the woodpile."

"These specifications shall be known as the 'Association of Iron and Steel Electrical Engineer Specifications.' It is intended that they apply to all automatic engine stops of whatever kind or method, in so far as they or any part of them may be applicable."

EXHIBITORS

Aero Pulverizer Company
 Alliance Machine Company
 Allis Chalmers Mfg. Company
 American Heat Economy Bureau
 Appleton Electric Company
 Automatic Reclosing Circuit Breaker Co.
 The Andresen Company
 American Arch Company, Inc.
 Bacharach Industrial Instrument Co.
 Baker R & L Company
 R. H. Beaumont Company
 Benjamin Electric Mfg. Company
 Bussmann Mfg. Company
 Bartlett Hayward Company
 Boxill Bruel Carbon Brush Company
 Chapman Valve Mfg. Company
 Chicago Fuse Mfg. Company
 Chicago Pneumatic Tool Company
 Corliss Carbon Company
 Crocker Wheeler Company
 Crouse Hinds Company
 Cutler Hammer Mfg. Company
 Cutter Electrical & Mfg. Company
 Delta Star Electric Company
 M. H. Detrick Company
 Economy Fuse & Mfg. Company
 Edison Storage Battery Company
 Electric Controller & Mfg. Company
 Electric Power Equipment Corp.
 Electric Storage Battery Company
 Electro Service Company
 Elwell Parker Electric Company
 Electric Materials Company
 Electric Service Supplies Company
 Electric Journal
 Electro-Labs Company
 Fuels and Furnaces
 General Electric Company

The Hayward Company
 The Hagan Corporation
 Hyatt Roller Bearing Company
 Industrial Engineer & Electrical World
 Iron Age
 Johns-Manville, Inc.
 The Johns Pratt Company
 Keystone Lubricating Company
 Lakewood Engineering Company
 Lumen Bearing Company
 London Steam Turbine Company
 Liptak Fire Brick Arch Company
 Martindale Electric Company
 Mercury Manufacturing Company
 Wm. G. Merowit
 Mutual Electric & Machine Company
 Mutual Foundry & Machine Company
 National Carbon Company, Inc.
 Nichols Lintern Company
 Norma Company of America
 R. D. Nuttall Company
 Northern Equipment Company
 Ohio Electric & Controller Company
 Packard Electric Company
 Pittsburgh Electric & Machine Works
 Pittsburgh Transformer Company
 William Reed Engineering Company
 Reliance Elec. & Engineering Company
 Republic Flow Meter Company
 Rockbestos Products Corp.
 Rollway Bearing Company, Inc.
 Rowan Controller Company
 Shepard Electric Crane & Hoist Co.
 Spencer Turbine Company
 SKF Industries, Inc.
 Square D Company
 Standard Underground Cable Company
 The Superheater Company
 Schweitzer & Conrad, Inc.

Thomas Flexible Coupling Company
 Thompson Electric Company
 Tide Water Oil Sales Corp.
 Trumbull Electric Mfg. Company
 Tool Steel Gear & Pinion Company
 United States Graphite Company
 V. V. Fittings Company
 Van Dorn Electric Company
 Western Electric Company
 Westinghouse Elec. & Mfg. Company
 Wickes Boiler Company

SPECIAL FEATURE—FOUNDRY SHOW

Atchison Graphite Company
 Automatic Transportation Company
 Bridgeport Safety Emory Wheel Co.
 Buffalo Scale Company
 Cleveland Pneumatic Tool Company
 Electro Metallurgical Corp.
 George J. Hagan Company
 Harbison Walker Refractories, Inc.
 Ingersoll-Rand Company
 Mahr Manufacturing Company
 National Carbon Company
 National Engineering Company
 Ohio Brass Company
 Ohio Steel Foundries
 Osborne Manufacturing Company
 Pangborn Corporation
 Pittsburgh Electric Furnace Corp.
 Pittsburgh Transformer Company
 Robertson Cataract Company
 Sce-Lite Products Company
 Truscon Steel Company
 Venango Sand Company
 Westinghouse Elec. & Mfg. Company
 Whiting Corporation
 Worthington Pump & Machine Co.

A. E. S. C. Approves Specifications

The American Society for Testing Materials, in submitting their standard Specifications for Staybolt, Engine Bolt and Extra Refined Wrought-Iron Bars, A84-21, for Refined Wrought-Iron Bars, A41-18, and for Wrought-Iron Plates, A41-18, state that the preparation of these date from 1905 to 1913, the first work in this field having been done on the first named group of materials in 1905.

The specifications for staybolt iron remained tentative for five years. In 1910 they were revised and adopted as standard by the society. In 1912, the requirements for strength, elongation and reduction of area were slightly raised, and a new section on each test was included. The addition of a suitable vibratory requirement for staybolt iron has not yet been possible on account of the impossibility of formulating a standard method of test that could be adhered to strictly on any two existing types of testing machines. In 1917, the specifications for staybolt iron were revised extensively; in 1920, a revision was made in regard to the permissible variation in diameter, which was adopted as standard in 1921. The first specifications for engine bolt iron were adopted in 1912, and after a number of revisions, adopted in their revised form as standards of the A. S. T. M. in 1921. The tentative specifications for extra-refined wrought-iron bars were developed in 1919, being designed to cover large rectangular bars used in the construction of locomotives and for similar purposes. These were adopted as standard by the A. S. T. M. in 1921, in which year the three sets of specifications for staybolt iron engine bolt iron, and extra-refined wrought-iron bars were consolidated under the title given above.

The Specifications for Refined Wrought-Iron Bars were first written in 1912, by the A. S. T. M. Committee

A-2, on wrought-iron, being intended to cover a grade of iron suitable for general forging, smithing and construction purposes. Following their adoption as standard, a number of revisions were made, and they were again adopted by the society in 1921.

The Specifications for Wrought-Iron Plates date back to 1913. Two classes of iron are provided for, in both of which it is specified that the material shall be free from any admixture of steel. The specifications stood without revision until 1918, when minor modifications were made. They have since been adopted as a standard of the society.

The special committee which recommended to the A. E. S. C. approval of these three sets of specifications as tentative American standard was headed by Col. E. C. Peck, representative of the American Society of Mechanical Engineers on the A. E. S. C. In addition, it included representatives of the following organizations.

American Marine Association, Shipbuilding Standardization Committee.

Department of Commerce.

American Institute of Mining and Metallurgical Engineers.

United States Navy, Bureaus of Engineers and Construction and Repair.

Association of American Steel Manufacturers.

American Society for Testing Materials.

Society of Naval Architects and Marine Engineers.

This committee further recommended that the American Society for Testing Materials should be designated sponsor, under A. E. S. C. procedure, for the future development and revision of these specifications.

Electric Drive for Centrifugal Fans, Blowers and Propellor Fans

Characteristics of Fans Operated at Various Percentages of Rating
with Curves Showing Pressures, Velocity Heads,
Horsepower Required, Efficiencies

By GORDON FOX*

PART I.

AIR and gases are handled by four general types of apparatus, namely, centrifugal fans, blowers and compressors, propeller fans, positive pressure or displacement rotary blowers and reciprocating compressors. This article deals with centrifugal and propeller types, fans and blowers.

Centrifugal fans cover all types in which air or gas is drawn in axially from one or both directions and discharged radially or tangentially by the rotating paddle wheel. Propeller or disc fans discharge axially, the blades being of propeller type.

Centrifugal fans are constructed in a variety of types for specific purposes. The simplest design is the cone fan or wheel which has no housing. This type of equipment is used for introducing air into rooms where no distributing system is required and for exhaust ventilation where the resistance to be overcome is moderate. This type of wheel draws the air in axially and discharges it approximately radially.

The majority of centrifugal fans are equipped with a housing of volute shape which functions to direct the air and assists in converting the radial flow, due to centrifugal force, into tangential flow around the housing to the discharge opening. Exhaust fans are commonly provided with a single air inlet on the side opposite the drive while blowers are commonly arranged to receive air from both sides the latter arrangement affording a little higher efficiency.

Steel plate fans are those built with a steel plate housing and paddle wheel blades. Volume and pressure blowers are provided with a cast iron housing. Fans and blowers may be further distinguished according to the general type of vanes or blades used. The ordinary steel plate fan impeller carries a small number of blades which are approximately flat and radial. If a fairly high pressure is to be developed, the blades are relatively deep in a radial direction. For large volumes the axial width is increased. Fans of this type develop pressure largely through the action of centrifugal force. The impeller of a multiblade fan carries a large number of blades which are comparatively shallow in radial dimension. In this type of fan the pressure is developed more by change of direction and impact of the blades against the air, rather than by centrifugal force. Multiblade fans are normally operated at speeds considerably higher than fans of the paddle wheel type, they are also somewhat smaller for a given pressure and more efficient.

Propeller Fans.

Fans of the propeller or disc type are well suited for large volumes at low pressure, less than one ounce per square inch. They are widely used for ventilating, cool-

ing and exhausting. In the larger sizes, they find applications as boosters for mine ventilation and for cooling towers.

Steel Plate Fans.

The varied designs of this type of fan find a wide range of applications which require moderate volumes and pressure less than a maximum of 12 oz. per sq. in. They are used for heating and ventilating systems having considerable friction in the piping. They are used for low pressure blast for forges, furnaces and cupolas. They are used for forced and induced mechanical draft. They are used for collecting and conveying dust, shavings and other light weight materials. Multiblade fans are suited to low pressure service of the above character, but are not applicable to systems conveying solid matter.

Volume Blowers.

Volume blowers with cast iron housing are particularly suited to moderate volumes and are applicable for blowing pulverized fuel into kilns or furnaces, for boiler draft and forge fires requiring not over 4-oz. pressure. As an exhaustor, they are well adapted for gritty dust and for handling smoke or gases which would cut or destroy steel plate housings. Cast iron pressure blowers are used for similar duty at pressures up to 14 oz.

Fan Characteristics.

The characteristics of a fan with respect to pressure, volume, speed, efficiency and power have a material bearing upon proper motor and control application. It is therefore desirable that the fan performance receive careful consideration in connection with the selection of electrical equipment.

In much the same manner that a generator may be under-compounded or over-compounded, giving either decreased or increased voltage with variation of load, fans may be designed to give either decreased or increased pressure as the delivery increases. The curve showing the relations between pressure and delivery is commonly termed the "fan characteristics." Curve B, Fig. 1, is the pressure characteristics of a fan with drooping regulation, while Curve B, Fig. 3, represents a fan having a rising pressure curve.

The performance characteristics of a fan are controlled largely by the shape of the impeller blades. With forward directed blade tips, the pressure rises from the point of "shut off" pressure at zero discharge to a considerably higher pressure at rated delivery. With radial or backward curve blade tips, the pressure falls off as the delivery increases and the highest pressure is developed at or near the "shut off" point.

The static efficiency curve in all cases starts at zero for no delivery, reaches a maximum and then drops to zero again at maximum delivery, corresponding to zero pressure. A fan may be operated at any period on its

*Electrical Engineer, Freyn, Brassert & Company, Chicago, Ill.

characteristic, with corresponding conditions of pressure and volume. It is desirable, however, to operate at or near the conditions giving maximum efficiency.

Pressure is developed by a centrifugal fan partly due to the revolution of the impeller, which imparts to the air a peripheral velocity as it leaves the fan rotor. Part of the pressure caused by centrifugal force imparting radial velocity which is convertible in part to pressure through the action of the volute housing or by means of diffusing vanes within the housing. With forward curved

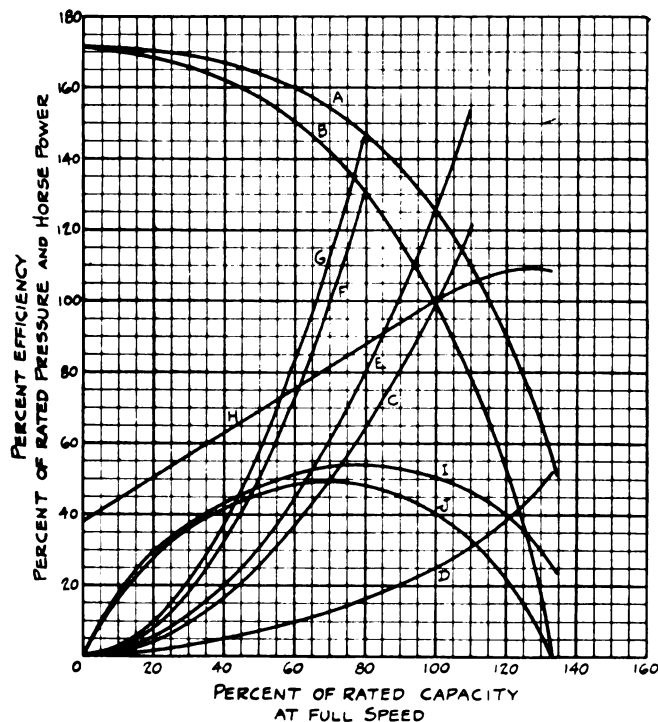


FIG. 1—Characteristics of a fan operating at full speed with rated discharge and throttled to give 80 per cent of rated discharge.

- A—Per cent of rated total pressure developed.
- B—Per cent of rated static pressure developed.
- C—Static pressure required by system—normal.
- D—Velocity head.
- E—Total pressure required—normal.
- F—Static pressure required by system when throttled to give 80 per cent of rated discharge.
- G—Total pressure required by system when throttled to give 80 per cent of rated discharge.
- H—Per cent of rated horse power required.
- I—Per cent total efficiency.
- J—Per cent static efficiency.

blades the portion of the energy present as tangential velocity of the air or gas leaving the impeller is relatively large. Thus in the latter type of fan an increase in volume leads to an increase in pressure. Due to the relatively large tangential component and small radial component of air velocity in a fan having forward curved blades, the efficiency of this type of fan is relatively high. The pressure developed by a fan having forward curved blades is considerably higher than that of a radial blade fan having the same tip speed.

Static and Velocity Head.

Two components of head are supplied by a fan, namely the static head and the velocity head. The static head is the measured pressure exerted in all directions against the fan housing and ducts at the fan discharge. In the case of a fan receiving air at atmospheric pressure and discharging ultimately to the atmosphere the static pressure against which the fan works is caused

solely by the frictional resistance to air flow in the ducts, furnace, etc. Static pressure may be measured by a draft gauge introduced radially into the air duct at the fan discharge. In addition to the static head, the fan must produce sufficient head to impart the necessary velocity to the air. This velocity head, multiplied by the volume, represents the kinetic energy in the air at the point of ultimate discharge. The velocity head at any point is represented by the difference between the static pressure and the pressure indicated by a gauge connected to a pipe introduced into the duct system in an axial direction against the flow. The total head developed by the fan is the sum of the static and velocity heads. If the discharge of a fan is wide open the static head is zero. If the discharge is totally closed the velocity head is zero and the static head equals the total head.

System Head.

The resistance to flow of air through any duct system or other obstruction is proportional to the square of the velocity. Likewise, the velocity head is proportional to the square of the velocity. Thus the normal static head of a given system is represented by a curve, such as C, Fig. 1. The velocity head curve is similar, such as D, Fig. 1. The total head curve is represented by the sum of static and velocity heads and is indicated by curve E, Fig. 1. If the intake of a fan be at one pressure, a vacuum for instance, and if the discharge be at another pressure, as at atmospheric pressure, the system pressure is not zero with zero discharge, but corresponds to the difference between intake and discharge conditions.

A fan connected to a given system will discharge such a quantity that the system pressure and the fan pressure correspond; thus in Fig. 1, the fan discharges 100 per cent capacity against a system requiring static head represented by Curve C. If the friction of the duct system be increased, as by a damper, so that the static head required by Curve F, the fan will deliver 80 per cent of rated capacity.

Fan Selection.

The type of fan selected with reference to the pressure characteristic, depends on the requirements of the application. The drooping pressure characteristic is more frequently suitable. Wherever it is desired to maintain approximately a constant volume delivery, independent of changes in the resistance of the discharge, a steeply sloping pressure characteristic is desirable as the volume does not vary widely with considerable changes in pressure. For instance, a fan of this character is desirable for forced draft installations, tending to maintain a given volume with changing fuel bed conditions.

Where it is desired to control the volume delivered by means of a damper, a slightly sloping characteristic is desirable, giving control yet minimizing the pressure loss at the damper due to the necessity of increasing the pressure in order to reduce the volume.

Where two or more fans are to operate in parallel, discharging into a common duct or system, a drooping pressure characteristic is necessary to insure proper division of the work. This condition is similar to the relationship between motors or generators working in parallel.

In some cases a comparatively flat characteristic is desirable in order that a fan may maintain approximately constant pressure on a system, independent of the delivery. Thus in ventilating a building or a mine, it is desirable that, when one section is shut off the pressure on other sections be not affected.

In selecting a fan having a sloping pressure characteristic, such as shown in Fig. 1, a slight error in calculation of duct resistance, etc., will not materially affect the volume obtained. The volume delivered by a fan having a flat characteristic or a rising characteristic is decidedly influenced by a slight change in system pressure so that conditions should be quite accurately known to insure desired results.

Power Required.

The power required to drive any centrifugal or propeller type fan or blower is a function of the volume and the pressure or vacuum obtained. For a given fan and restriction of discharge;

The horsepower varies directly with the density of the gas or air handled and is therefore also affected by the temperature.

The pressure varies as the square of the speed.

The torque varies likewise as the square of the speed.

The power varies approximately as the product of pressure and volume or torque and speed and is therefore proportional to the cube of the speed.

$$HP = \frac{5.2 Q \times G}{33000 \times e} \times \frac{W}{0.075}$$

5.2 = lb. pressure per sq. ft. at 1-in. water gauge.

Q = volume, cu. ft. per min.

G = water gauge pressure or draft in inches =

1.728 × pressure in ounces per sq. in.

e = fan efficiency.

= approx. 40 per cent for paddle wheel fans.

48 per cent for multi-vane fans.

60 per cent for cone fans without a housing.

30 per cent for propeller fans.

W = Density of air or gas handled in lbs. per cu. ft.

0.075 = Weight of standard air at 65 deg. F. in lbs. per cu. ft.

In ordinary air handling problems the element $\frac{W}{0.075} = 1$. At high temperatures or when handling gases other than air, the density W must be determined for conditions of operation.

The efficiencies stated are typical for the fan types mentioned, but are subject to considerable variation in specific cases so that the efficiency of the fan in question should be used. If static pressure is used, static efficiency must be taken. If total pressure is used, total efficiency must be taken.

A centrifugal fan of a given size may be rated for a range of pressures and volumes according to the speed at which it is to be operated. The rating given at any speed usually represents conditions giving the best efficiency at the speed. The exact relation of efficiency to rating is shown by the characteristic curves. The volume actually delivered by a centrifugal fan operating at a given speed will vary with the system pressure and the efficiency will be ordinarily less for volume other than normal rating, especially for volumes in excess of normal. If an increase in volume is obtained by increasing the fan speed the fan efficiency will be maintained, but if increased volume results from decrease in system pressure, a lowered efficiency is to be expected. In order that good fan efficiency may be obtained it is desirable that a fan be selected to operate at a speed such as to give its best performance over the range of requirements of the system.

As above stated, a fan which is operated over a range of speeds will maintain a good efficiency throughout the range if the volume delivered at each speed corresponds to best operating conditions at that speed, a condition which is more or less automatically approximated in usual operation.

Factors Affecting Load.

Reduction of the inlet or discharge area of a centrifugal fan reduces the power required, the speed remaining fixed. Increase in area has the opposite effect. Changes in area affect the system pressure, but the variation in volume thus caused has the predominating influence on the power required. At a fixed speed the power consumption of centrifugal fans varies approximately in proportion to the volume, as shown by Curve H, Fig. 1, or at a faster rate, as shown by Curve H, Fig. 3.

With entirely closed outlet, the power required for churning will run 20 to 30 per cent of rated load. In some fans having a drooping pressure characteristic, the power required with free discharge does not greatly exceed that for normal conditions. This condition is indicated in Curve H, Fig. 1. A fan having a rising pressure characteristics increases its power requirement rapidly and far above rated load if a volume much in excess of normal is permitted. A fan, such as shown in Fig. 1, does not require much excess motor capacity, whereas a fan having rising pressure characteristics should be liberally motored if there is any likelihood of much variation in system conditions or if conditions cannot be accurately predetermined.

Obstructing the discharge of a propeller type fan increases the load until it reaches about 200 per cent normal value if the discharge is entirely closed. The writer recalls a case in which a number of propeller type fans were exhausting into a common ventilating duct. When the fans on the upper floors were started they effected a partial obstruction of discharge of the fans on the lower floors, overloading the motors driving these fans.

Any type of fan or blower may overload its motor if the speed exceeds normal value. A centrifugal fan motor may be overloaded if the discharge openings are increased above normal. Propeller fans may be overloaded by restricted discharge. In view of these facts it is evidently desirable that controllers for motors driving fans and blowers be equipped with overload protection. However, as fan loads are not normally of a widely fluctuating nature, fuses will often be satisfactory.

Motor Selection.

The majority of centrifugal fans operate normally at constant speed and with more or less constant load. For such drives shunt wound d.c. motors or squirrel-cage induction motors are commonly used, according to the nature of the service available. For the larger units synchronous motors. Because of the usual continuous operation and high-load factor, the high efficiency of the synchronous motor is advantageous.

Inasmuch as the power required by a fan varies rapidly with change of speed, it is important that care be taken to see that the rated fan speed is closely met. The actual full load speeds of shunt motors are likely to vary 3 to 5 per cent from rated speed, due to manufacturing variations. The hot speed is usually 3 to 5 per cent higher than the cold speed. A resulting variation of 6 per cent from rating would alter the fan pressure about 12 per cent and the motor load about 19 per cent. The need for accuracy in the matter of speed is thus evident.

(Continued in October.)

Buffalo as a Steel Producer

Steady Growth of This Strategically Located Lake Port.
A Super-Power Center.

By LLOYD S. GRAHAM

MANY cities in the United States produce more steel and iron than Buffalo, but there are few which have seen such a swift development of the industry since its beginning in Buffalo about 20 years ago, when the Lackawanna Steel Company entered the Buffalo district.

The Lackawanna came avowedly because of Buffalo's highly valuable water frontage for deep draft lake steamers and associated transportation advantages for raw materials. The things necessary to steel manufacture can be assembled in the Buffalo district with economy: Coal but two or three hundred miles away by rail; ore and limestone available from the entire Great Lakes region by boat without rehandling. There were other advantageous factors too incidental to mention.

The New York State Steel Company, now known as the Donner Steel Company, and the Wickwire Steel Company quickly followed the Lackawanna in the Buffalo district along with well-known producers of pig iron almost exclusively, such as the Rogers, Brown Iron Company and the Buffalo Union Furnace Company, to mention the most notable.

Present development of the industry in Buffalo is in the direction of quality of products and specialization rather than in expansion of facilities for bulk production. The exception to this is the Lackawanna, which has a large and well-known plan of development, which includes greatly increased production facilities in the very near future.

On the other hand a highly interesting change is taking place at the plant of the Donner Steel Company in the increasing production of alloy steels in all sorts of forms. According to W. W. Hancock, secretary of the Donner Steel Company, it is planned to develop this phase of steel production both as to quality and quantity.

In much the same business attitude the Wickwire-Spencer Steel Corporation is constantly developing the manufacture of its numerous wire products, both as to methods of manufacture and the addition of new products to the already astonishing and interesting list.

The Donner Steel Company holds the distinction of being the largest Buffalo corporation in point of capitalization operating within the city limits. Its capital stock, common and preferred, totals at the present time \$13,522,500.00.

Like all of the other Buffalo plants in iron, steel and allied industries, Donner is working nearly to capacity at the present time and the future is considered exceptionally good.

Production at the Donner works now includes basic, foundry and malleable pig iron, blooms, billets and slabs; railway, automobile and carriage spring steel, as well as a wide variety of structural shapes, merchant bars and bar products—rounds, squares, flats, bands, half-rounds, half-ovals, hexagons, concrete reinforcing bars, special automobile sections and the like.

The main plant covers 67 acres, and has unusually valuable dockage advantages. The yards and docks are nearly 12,000 ft. long and are equipped with three Brown ore bridges. The ore yards have a capacity of 800,000 tons.

Two blast furnaces of 500 tons capacity each are in operation.

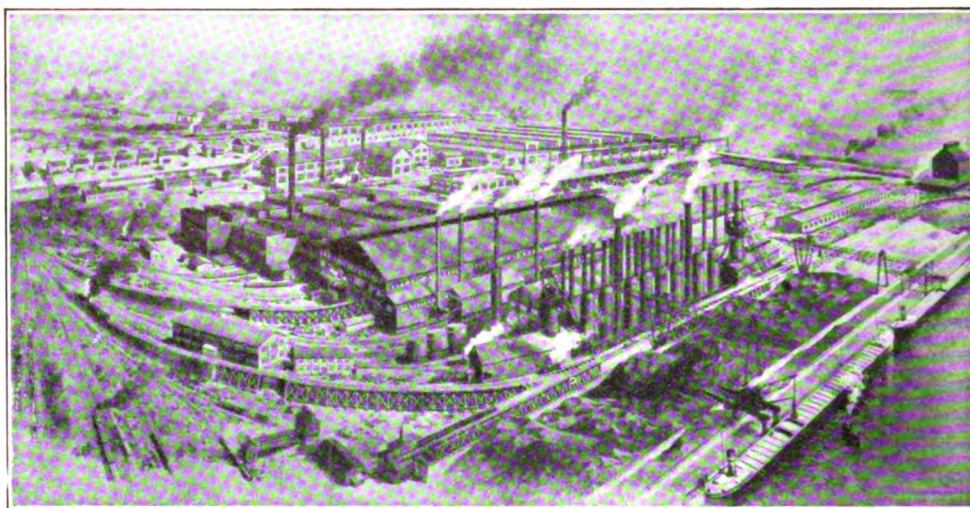
There are 10 open hearth furnaces of 90 tons capacity each, blooming mill, billet mill, plate mill, three merchant mills, boiler plants and the usual auxiliary equipment of cranes, charging machines, all operated by electrical equipment. The plate mill is 84-inch capacity. The merchant products are turned out by a 14-inch "cross country," producing switch plates, drift keys, channels, I-beams, etc.; a 10-inch semi-continuous mill, and an eight-inch semi-continuous mill, with a large pickling plant operated in connection with them.

Associated with M. A. Hanna & Company, formerly known as the Buffalo Union Furnace Company, the Donner Company owns a half interest in the Donner-Union Coke Corporation, the plant of which is contiguous to and lies between the two parent companies. The coke corporation is equipped with 150 Koppers ovens and owns 500 seventy-ton hopper coal cars.

The Donner plant itself has nearly ten miles of standard gauge railroad trackage and two and one-third miles of narrow gauge.

Besides the connection with the coke corporation, the Donner company controls the Donner Steamship Company, which operates the Herbert F. Black, a 10,000-ton ore boat, launched in 1916.

It also owns the Donner Mining Company an electrically equipped iron mine in the Mesaba Range. Coal comes from the Westmoreland district and limestone from Michigan. Besides the ores from its own mines, it



Birdseye View of Wickwire-Spencer Plant.

buys a great quantity of lake ores.

In connection with its specialization in alloy steel, Mr. Hancock points out that the best results are insured at Donner by using the highest grade ores, the fact that the company operates its own open-hearth furnaces and uses no producer gas, taking all of the gas and tar produced by the ovens of the Donner-Union plant. The effort is being made because of natural and acquired advantages to build up a reputation as a producer of high grade alloy steel products.

This is in line with laboratory investigations by this and other companies, and the tendencies of the big automobile users of steel products to turn more and more to alloy steel, some pointed statements on the subject having been made recently by Henry Ford and others.

The Donner power equipment consists of one 6,000 kw. turbo-generator, three 1,000 kw. motor generators and six 250-kw. Buckeye generators. There are 10 gas-fired boilers, 10 coal-fired boilers and 10 open-hearth, waste-heat boilers.

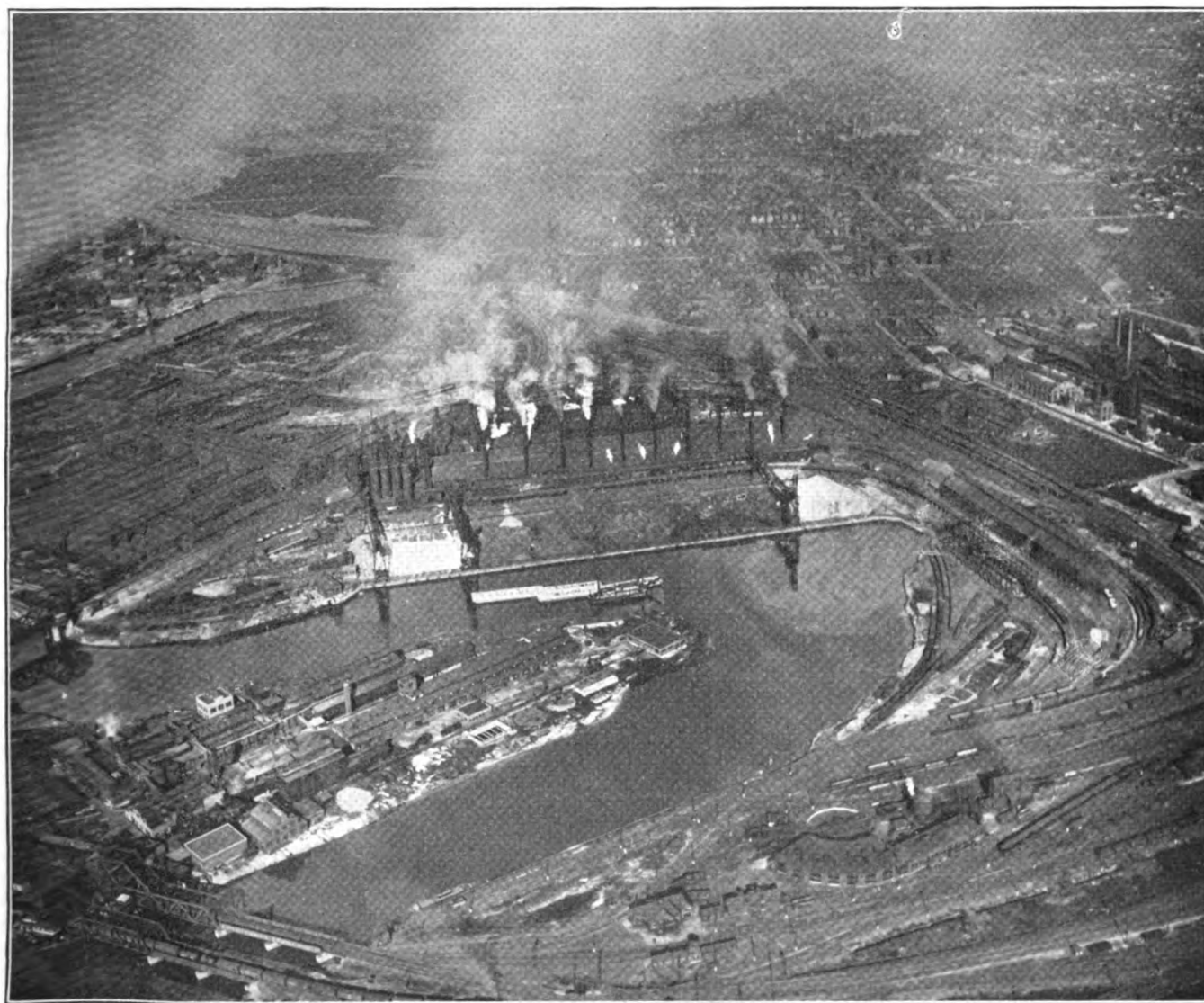
The Wickwire-Spencer Steel Corporation holds a rather unique and romantic place, particularly in the steel and iron business. After coming in contact with the more or less common-place details of every-day business, the examination into the development of the Wickwire-Spencer organization was most refreshing.

This company, whose early history is marked by the swift development of the present Buffalo plant of the corporation, was almost entirely owned by the Wickwire family until February, 1920, when consolidation was effected with plants in and about Worcester, Mass.; Mt. Wolf, Pa., and Blue Island, Ill., near Chicago.

This was a big step in the complete development of the exclusive manufacture of all sorts of wire products. The present corporation is so organized that it has practical control or supervision of all the steps, from the iron mines to the complete manufacture of the finest wire products known to civilized mankind. The Wickwire plant at Buffalo acts as a feeder of partially refined wire products for all of the other plants, and turns out enormous quantities of the coarser kinds of steel products besides.

According to a statement of Ward Wickwire, at the Buffalo works, the original establishment at Buffalo includes 120 acres, most of which is industrially developed. It is advantageously located on the Niagara River, and the main line of the Barge Canal. The deepest draft Great Lakes steamers can dock, as well as the canal boats. Iron ore comes down the Great Lakes from the west and the finished products, go to the markets in the east often over the canal.

At the Buffalo works are two 450-ton blast furnaces



Aeroplane view of Donner Steel Plant.

and four 60-ton open-hearth furnaces. There is a blooming mill, continuous billet mill, continuous rod mill, wire mill, nail mill as well as galvanizing, tinning, annealing, coppering and electric welding equipment.

All machinery is driven or controlled by electricity. About 60 per cent of the total power used is a by-product of the furnaces. The balance of the power is purchased from the Buffalo General Electric Company, which plant adjoins that of the Wickwire.

A list of the finished commercial products which the Wickwire-Spencer organization turns out at the present time is amazing. Practically everything in the wire line is included, from the heaviest wire ropes and cables to the finest wire used in jewelry and instruments of science.

The Buffalo works at this time is specializing on concrete reinforcing for use in the construction of highways and buildings. The fabricating plant of the Buffalo works furnished all of the reinforcing material used with concrete in the recently completed Hotel Statler of Buffalo, now the chief convention hotel of the city. Enormous quantities of it is being turned out now for the construction of paved streets and state roads.

In the nail mill, practically every kind of article in the nail line, from the finest tacks and brads made for special purposes to the heaviest of the common nails, are turned out in quantity.

Wire rods, fence wire, springs of every type and capacity, skid chains, and scores of other articles are all a part of the production of the Buffalo works. And besides all of those articles it turns out pig iron, steel billets, and wire rods in sufficient quantity to supply all of the other mills in the organization. Occasionally it has some pig iron and steel billets to sell, but this is becoming more and more rare as the diversity of wire products and production quantity increases.

In fences, it produces everything from barbed wire to the finest ornamental fences for lawns and gardens. Here one can see the manufacture of poultry fence and rabbit fences; of picket fences and mesh wire fences; of chain link factory fence and the almost impregnable factory fence of diamond mesh, galvanized both before and after fabricating. There are enclosures for elevators and enclosures for stock rooms, enclosures for financial institutions and others where valuables are kept. Here, also, one can see the manufacture of the fine, yet strong, wire mesh for use in reinforcing glass.

At the eastern plants are made the fine wire that goes into musical instruments, jewelry and all sorts of laboratory instruments, the fine crossed wires that one sees in surveying instruments and telescopes.

At Buffalo are made low and high carbon wire, round flat and shaped; wire rope, wire rods, wire rope fittings, wire forms, flat cold rolled wire, automobile and truck tow-lines, trellis, wire screen, tree guards, picture cord, wire lath, wire loops, wire and perforated metal grilles, garment hangers, guards for flower beds and lawn borders, guards for machinery.

Spiral stairways are fabricated at the Buffalo plant as well as the common iron stairs. Here are made cold and hot wound springs, compression springs, extension springs, torsion springs, flat and wound wire springs, springs for special uses in the manufacture of automobiles.

The Buffalo plant turns out a great deal of equipment used in the oil field and in mining, construction of buildings and in connection with steamships. It manufactures bank screens, sand screens, mining screens, coal screens, and gravel screens; wire oil well lines, wire sifters and

wire sieves, steel lockers, cables and wire ropes of all sizes and types, wire cloth for conveyor belts and drying machines, drill rods, sash and telegraph cord, guy wire ropes, wire partitions.

An interesting development of recent years in which the Buffalo works of the Wickwire-Spencer Corporation has participated to the utmost, is the wide industrial use of wire mesh and metal cloth of various kinds. For instance, some automobile manufacturers have recently adopted the use of metal cloth tacked on the underside of automobile seats instead of slats, because it has proven more substantial and is quicker to apply.

For that reason the Buffalo works and some of the other plants of the Wickwire-Spencer organization have gone into the extensive manufacture of all kinds of metal cloth. It puts out diamond mesh, square mesh and double crimped wire cloth. It manufactures brass, bronze and copper wire cloth for all sorts of purposes as well as the usual variety of sizes and qualities for window screening.

In the line of sanitary metal products, which is about the only way in which it diverges from the strictly wire and wire products line of manufacture, it puts out tinned and enameled kitchen goods, many of which are wire products, and enameled white goods and bathroom fixtures.

The Wickwire-Spencer Steel Corporation owns the Cardiff and Homer mines at Iron River, Mich., and has an interest in the Hanna Ore Mining Company. Its mines are electrically equipped throughout with the most modern type of apparatus. It owns extensive quarries near Gasport, N. Y., from which it obtains crushed, sized and pulverized limestone and dolomite. It is interested in the American Steamship Company, which owns and operates 17 Great Lakes steamers.

The head office of the corporation is in Buffalo, at the Wickwire plant, but extensive sales offices are maintained in Worcester, Boston, Chicago, Detroit, San Francisco, Los Angeles, New York, Philadelphia and Tulsa.

In the consolidation, which was effected in 1920, the Wickwire family acquired an interest in what is claimed to be the oldest finish wire plant in the country as well as the best known among the buyers of fine wire for musical instruments and jewelry, which is now known as the Spencer plant, near Spencer, Mass., in a little village up in the hills, miles from a railroad. Yet here descendants of the first English wire workers who came to America still work at the hereditary family trade and produce wire as fine or finer than that of their ancestors. The factory is operated by water power, and their fathers and grandfathers helped to make it a success and a trade name to be reckoned with.

Another interesting plant in Buffalo district is the Rogers, Brown Iron Company. This was formerly the Buffalo & Susquehanna Iron Company, but was taken over by the present company 14 years ago. It covers 95 acres, and operates four blast furnaces of about 350-ton capacity. It has the usual equipment for turning out pig iron in volume, pig machine and four cast houses for sand casting.

It is equipped with deep water dockage space and a reinforced concrete ore dock 2,096 ft. long, with six Brown ore bridges for unloading. Its ores come from Michigan and Minnesota, and its coke from Sykesville and Tyler, Pa., ovens. It turns out foundry, basic and malleable pig iron, and has been running to capacity the last six months.

All equipment in this plant; bridges, cranes, transfer cars, and the like, is operated by electricity, all of which

is generated within its own plant. In point of equipment for turning out a high volume of a specialized line, this plant is said to be one of the most completely and efficiently equipped in the country.

Buffalo is said to be one of the largest producers of pig iron in the world. The annual production from all furnaces working to capacity at the present time is approximately 4,000,000 tons. Practically all of the ores used in the Buffalo district come from the Lake Superior region, from which it is shipped by boats, which dock almost without exception at the very docks of the plants which use the ore.

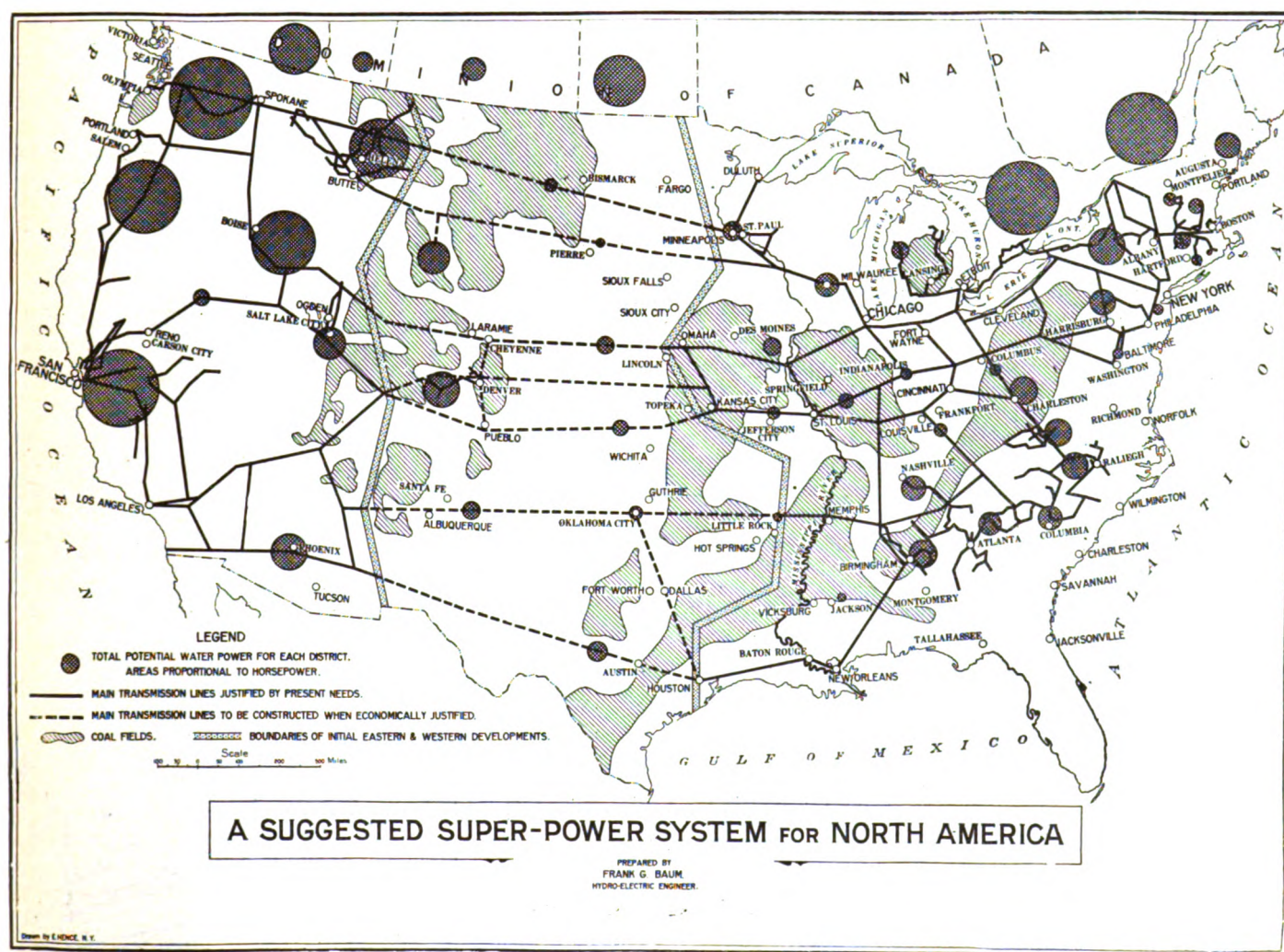
Many of the plants in the Buffalo district, with the notable exception of the Wickwire works, use limestone, which is also shipped from the upper Great Lakes region by boat.

There are in the Buffalo district a large number of plants that manufacture some metal specialty and are thus allied to the industry. The Seneca Iron & Steel

Company is located only a short distance from the Lackawanna Steel plant and specializes in steel plates.

Besides those already mentioned there are nearly 300 foundries and metal working shops of various sizes and specialties. The value of the metal trades in Buffalo can best be understood by the statement that nearly 40 per cent of the city's wage-earners draw their pay envelopes from the iron or steel industries or allied metal trades in the various lines.

In a city of highly diversified industries, perhaps the most highly diversified of any city of its size in the United States, the metal trades are without doubt the dominating factor. All this is considered from the standpoint of the industries in the Buffalo district rather than those within the city limits, from the great Lackawanna plant, which overshadows all others in importance to the comparatively small shop which turns out some special metal product.



NORTH AMERICA AN ELECTRICAL UNIT

Buffalo's position as an electrical center is legendary. Niagara Falls, only a few miles distant was the first great hydro-electric development in this or any country. Its comparative magnitude is shown by the size of the circular area cross-sectioned.

The system outlined above is one of the most far reaching conceptions of modern times; it was prepared by Frank G. Baum, hydro-electric engineer, and carries the endorsement of Gen. Tripp, who characterizes the single system as not only practicable and desirable, but essential to American progress.

Modern Lighting in Steel Mills

Elimination of Accidents Due to Inadequate Lighting Now Merely
a Matter of Intelligent Selection

By J. J. McLAUGHLIN*

ARTIFICIAL illumination is an all-important factor in the industrial plant, for if it is not installed properly and a sufficient amount provided, it concerns the individual workman, the employer and the state. Under poor lighting conditions, the workman eventually suffers defective eyesight, which may bring about other accidents that may happen to him while at work.

The employer suffers through slow production and inaccurate work and perhaps eventually the loss of a trained workman, or in case of accident to the employee, is required to pay compensation. The state loses indirectly, sometimes directly, through the necessity of taking care of one of its citizens or his family depending upon him.

Often poor and inadequate illumination in an industrial plant is the direct cause of accidents. Figures compiled by Mr. R. C. Simpson of the Travelers Insurance Company show that during the year 1919 there were more than 2,000,000 industrial accidents causing loss of time. Of this number 25,000 were fatal. The following extract from an article published by an insurance company gives some interesting data on the relation between lighting and safety:

"There is some foundation for assuming that 18 per cent of our industrial accidents are due to defects in lighting installations. On that basis the services of 108,000 men for one year are lost annually because the illumination provided is not adequate for the safety of the workmen. That this condition could exist year after year is all the more reprehensible, because of the fact that the remedy is so easily applied, and has beneficial results in many ways other than the safety involved. Accidents caused by carelessness, inattention or ignorance can be eliminated only by a long continued painstaking, educational campaign, often involving a change in long established habits. Elimination of accidents due to inadequate or improper lighting is simply a matter of purchasing the proper equipment and installing it under competent directions. In fact, it seems proper to include illumination in the list of mechanical safeguards, for reason that lamps and reflectors provide a guard; illumination points out the hazards just as effectively as a railing points out the danger of, and provides protection against, the hazard of a revolving flywheel."

Under poor lighting conditions accidents are likely to occur at a period of the work-day when the workman is fatigued and is more than ever in need of good illumination. This happens in the late afternoon especially in the fall and winter seasons, when the daylight fails rapidly at this time, also on the night shift, when the artificial illumination is the only source.

From the above standpoint particularly the industrial plants that should give thought to good lighting are the iron and steel mills.

The lighting requirements of such plants present a problem to the engineer which frequently requires special treatment in order to insure economical and efficient

illumination,—economy over such large scales may mean much. One of the main factors of the problem lies in knowing how to install lighting devices that will meet the legal demands of hygiene, mechanical safety, fire and

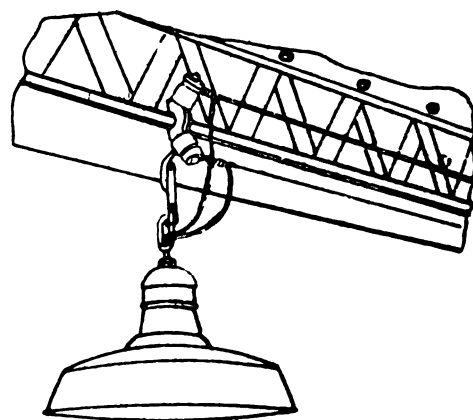
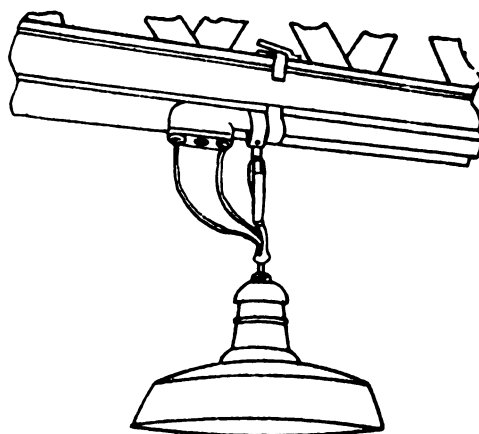
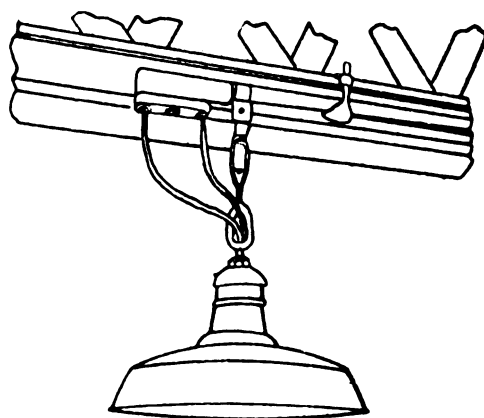


FIG. A—Methods of suspending fixtures from overhead beams.

*Illumination Bureau, Westinghouse Lamp Company, New York City, N. Y.

accident hazards, that will "stay put" and will remain efficient. The steel mill is not a ballroom; sturdiness is a prime requisite. The advantages of better illumination to modern industry, including reduction of accidents, increased production, and decreased spoilage, are becoming more apparent every day with the increasing number of up-to-date installations.

The quantity of light required in iron and steel mills varies according to the different operations carried on. This quantity may be determined from Table No. 1, giving the foot-candle values which experience has found desirable for the operations and locations.

A range has been given in each case, as it is impossible to set any one definite value owing to the influence of local requirements and surroundings upon the illumination necessary. Light colors for ceiling and walls where possible to keep them so, and stationary objects or rough work may permit the use of the lower values. However, with dark surroundings, smoky and dusty atmospheric conditions, rapidly moving machinery or prevalent accident hazards, there is a call for the higher values in the table.

Locating the lighting outlets is very important, and is naturally determined to a large extent by the proportions of the building, the size of bays and the ceiling height, at the same time considering the positions of the machines, especially the very high ones as might be found in roll mills, which would have a tendency to cast shadows if the outlets were not located around them properly. Thus the location of the outlets is important to insure the proper direction of light on the work.

In order to keep down the number of outlets to a minimum and to utilize the more efficient high wattage lamps,

the luminaires (lighting fixtures) for general broadcast mill lighting should ordinarily be mounted as high as possible. This can be done very well in iron and steel mills owing to high ceilings. The customary practice is to mount the luminaires either on the under side of the truss or to suspend them on a level with the bottoms of the trusses.

In cases of long narrow buildings, when the width is equal to or less than the height of the ceiling, one row of outlets down the center will ordinarily prove satisfactory. If, however, machinery is located near the walls, two rows of units should be provided. Or with one row of luminaires down the center of room, the angle reflector should be mounted on the side walls directing the light in towards the center of room, if workmen do not continually face the walls. In buildings where the width exceeds the height, the longitudinal rows should be so located that the distance between them does not exceed one and one-half times the distance of the light source to the floor.

When the ceiling is extremely high, as is found among large bays in steel plants, the mounting of the light sources as high as the ceiling trusses might result in a considerable portion of the light striking the upper section of the walls. Under ordinary conditions of dark and dirty walls, the absorption of light would be considerable thereby reducing the efficiency and the resultant illumination on the working plane. In such cases, angle reflectors mounted not less than 25 feet high along each side spaced not farther apart than one and one-half times their height above the floor.

Direct lighting is of course the most economical for steel mill work, supplied by the larger gas-filled Mazda

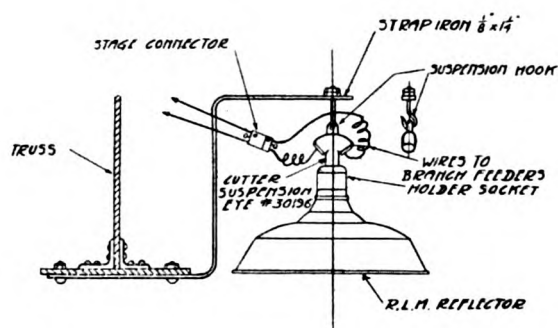
TABLE I—PRESENT STANDARDS OF FOOT-CANDLE ILLUMINATION FOR STEEL MILLS

	Desirable Illumination Foot-Candles*	
	Usual Conditions	Average Range
Steel and Iron Mills, Bar, Sheet and Wire Products		
Soaking pits and reheating furnaces.....	2	1-2
Charging and casting floors.....	3	2-4
Muck and heavy rolling, shearing (rough by gauge), pickling and cleaning.....	5	3-6
Fine plate inspection.....	15	10-20
Automatic machines, rod, light and cold rolling, wire drawing, shearing (fine by line)	6	4-8
Forge Shops and Welding		
Rough forging	6	4-8
Fine forging and welding.....	10	6-12
Foundries		
Charging floor, tumbling, cleaning, pouring and shaking out.....	5	3-6
Rough molding and core making.....	6	4-8
Fine molding and core making.....	10	6-12
Machine Shops		
Rough bench and machine work.....	6	4-8
Medium bench and machine work, ordinary automatic machines, rough grinding, medium buffing and polishing.....	10	6-12
Fine bench and machine work, fine automatic machines, medium grinding, fine buffing and polishing.....	12	8-16
Extra fine bench and machine work, grinding (fine work).....	10-50	
Sheet Metal Works		
Miscellaneous machines, ordinary bench work.....	8	5-10
Punches, presses, shears, stamps, welders, spinning, fine bench work.....	10	8-16
Tin plate inspection.....	10	6-12
Structural Steel Fabrication.....	6	4-8
Yards and Yard Thoroughfares.....	0.5	0.25-1

*A unit foot-candle is the illumination produced upon a surface one foot distant from and perpendicular to the rays coming from a one candlepower light source. In order that this may be easily understood, the illumination produced on a wall by an ordinary safety match held six inches from that surface would be approximately one foot-candle. Moonlight is on the order of one one-hundredth of a foot-candle; pale sunlight about 4,000 foot-candles.

lamps fitted preferably with porcelain enameled steel reflectors. These are more sturdy than the glass reflector units, although the latter may have a trifle higher initial efficiency, and useful where they are insured careful maintenance. The enameled steel is not affected by moisture, ordinary atmospheric conditions, or acid fumes. It

METHOD OF MOUNTING REFLECTORS



THIS METHOD OF MOUNTING IS RECOMMENDED WHEN THERE IS INSUFFICIENT CLEARANCE UNDER THE TRUSSES.
THE ENTIRE UNIT CAN BE REMOVED FOR CLEANING BY SEPARATING THE STAGE CONNECTOR, AND UNHOOKING.

FIG. B—Method of mounting reflectors.

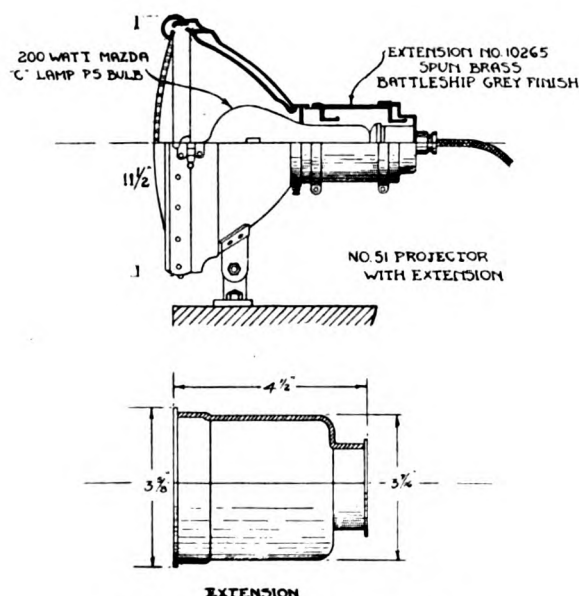


FIG. C—Detail of X-ray projector.

also has the advantage of being easily cleaned and will naturally withstand relatively rough service.

There are three general shapes in the porcelain enameled steel reflectors, namely the Standard R. L. M. Dome, the Standard Deep Bowl and the angle type. The most common of these three types is the R. L. M. It is made in sizes to accommodate 50-watt to 1,500-watt gas-filled Mazda lamps. The R. L. M. reflector is ideal for general overhead lighting because of its wide light spread and at

the same time the cutoff of $17\frac{1}{2}$ deg. below the horizontal sufficiently shields the brilliant lamp filament from the workmen's eyes.

In cases where it is necessary to provide illumination from the side as described above, the Standard Angle reflector should be used. With the overhead equipment

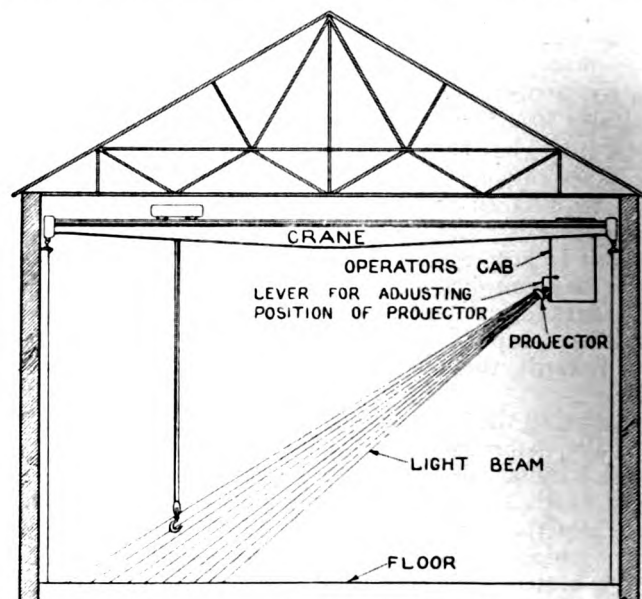


FIG. E—Showing detail of X-ray No. 51 projector with extension the purpose and mounting of same shown in Fig. E-1.

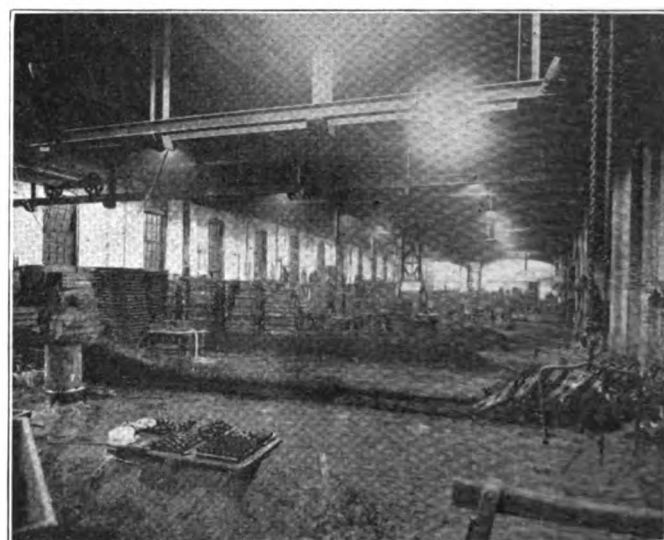


FIG. G.—A well lighted foundry, using two rows of standard bowl reflectors and 400-watt gas-filled Mazda lamps. Spaced on 25 ft. x 25 ft. centers.

that may be necessary above a crane, these angle reflectors mounted under the crane rails will supplement the general illumination, aiding especially that on vertical surfaces. All of these reflectors are made of steel base, and are coated inside and out with porcelain enamel. The first coat is a binder coat after which one coat of green is applied outside and two coats of white inside. Each coat is fired separately.

The open construction of the ordinary large mill requires special attention in the mounting of the luminaires,

not only to simplifying the installing but to help make the maintenance of the system easier, which will be explained later.

Fig. A illustrates some simple and practical ways of hanging the equipment from the lower members of the ceiling trusses. The schemes cover both conduit and open wiring.

A frequent problem is to avoid traveling cranes where

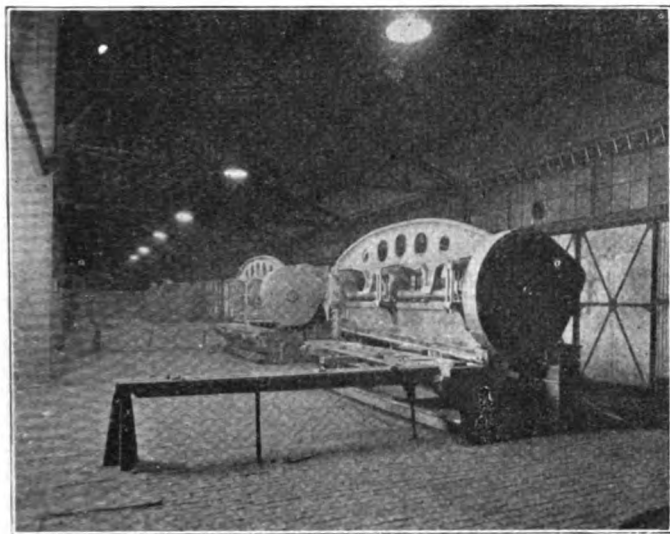


FIG. H — A well lighted shear, using one row of R.L.M. standard dome reflectors and 300-watt gas-filled Mazda lamps. A double row would largely eliminate some deep shadows on the side.

there is sufficient clearance between the bottom of the girder and the crane carriage. Fig. B shows a simple method which not only solves this problem but illustrates how the equipment may be readily removed for cleaning.

The above hanging methods would be satisfactory in places where the ceiling trusses are not so high, but that luminaires could be reached by a ladder, or where traveling cranes are in service from which the luminaires could

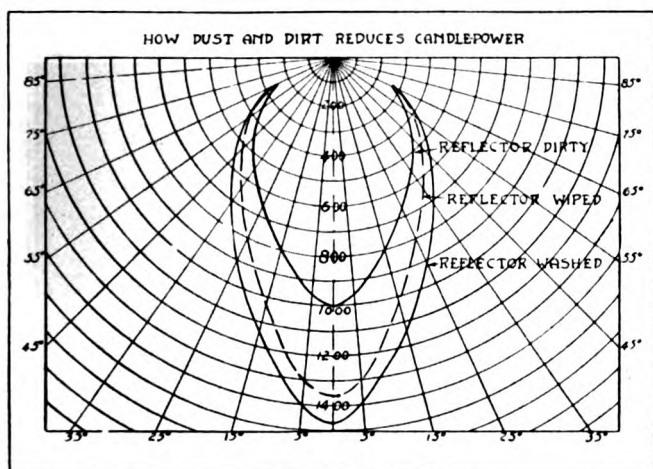


FIG. L—This chart illustrates the importance of inspecting and maintaining the lighting equipment.

be reached. However, in shops with very high ceilings where no cranes are in use, the pulley-socket or the automatic cutout hanger, illustrated in Fig. C, should be used. Such equipment will simplify the renewals of burnt out lamps and the cleaning of reflectors, thus reducing the

accident hazard entailed by other and harder ways of getting to the luminaires.

This pulley-socket or the automatic cutout hanger with an extension rope permits the lamp and reflector to be disconnected from the socket or hanger and lowered to the floor.

One other problem that presents itself in the lighting

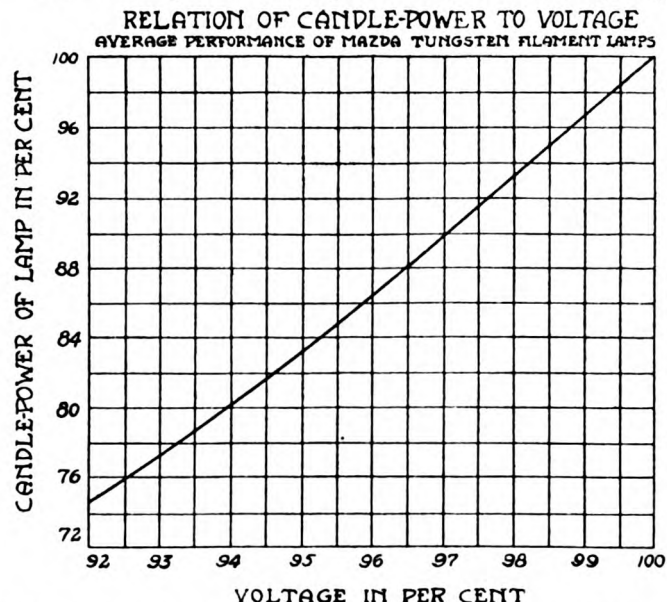


FIG. M—This chart illustrates the importance of installing the correct voltage lamps to suit the line voltage.

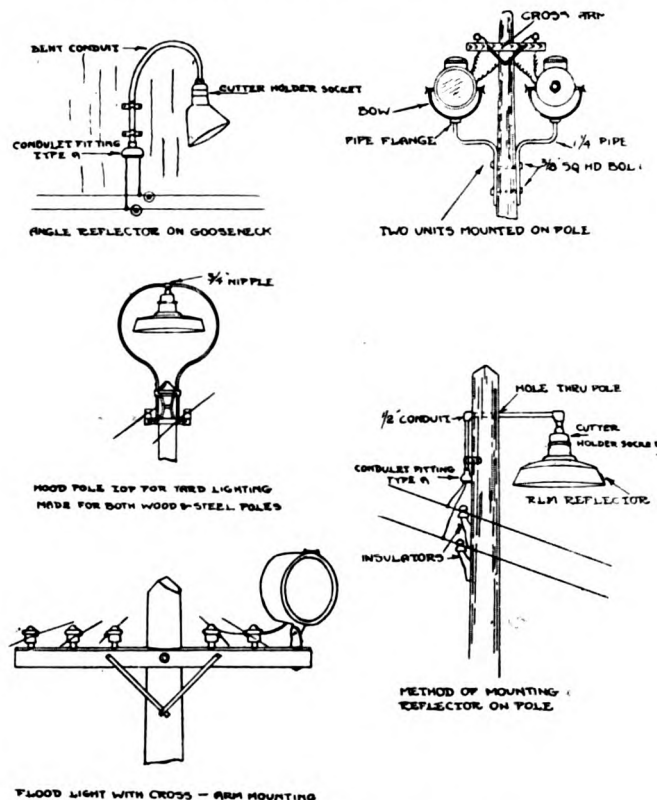


FIG. N—Yard lighting suggestions.

of a building wherein a traveling crane is in service, is the shadow the crane is likely to cast on the floor or work where it stops directly under the overhead lights. The staggered arrangement of the overhead luminaires or the use of angle reflectors on the side walls as described

above, helps to reduce or eliminate these shadows. Another way this can be solved and have the control of the light under the crane in the hands of the crane operator, especially when lifting or setting a load, is to mount a flood-lighting projector on the front or side of the operator's cab with a lever extending into the cab so he can control the direction of the projector beam conveniently. One type of projector suitable is illustrated in Fig. E. With the extension sleeve socket holder, a standard 200-watt gas-filled Mazda lamp can be used thus permitting the lamp to be set and burned in any position. For large or high cranes, a similar projector is available, using the standard Mogul base lamps in 300, 400 or 500 watts.

Figs. G and H illustrate well-lighted buildings in the steel mill industry, using the Standard Deep Bowl Reflector and the R. L. M. Standard Dome Reflector. Also Fig. J shows a well-illuminated building used for storing sheet steel.

Ordinarily the films of dust that settle on lamps and reflectors may be wiped off easily. However, in industrial shops this dust becomes moist and oily and when removed by merely wiping with a more or less dirty rag or handful of waste, leaves a thin invisible film of grease on the reflector to which a new coat of dust and dirt readily adheres.

In wiping such units, use as clean rags as possible and

preferably finish by rubbing the cleaned surface with tissue paper or paper towels.

When units are exposed to air carrying sulphur gases or are used in soft coal districts, there may be deposits of a thin brownish film on the reflectors that require warm soapy water washing to remove. This solution will usually suffice, preferably finishing by using warm rinsing water containing ammonia (about one part commercial ammonia, NH_4OH to eight parts water), thus securing quick drying and also eliminating the soapy film that would later retain dust.

Diluted acids that may without risk be used on crystal or plain (undecorated) opal glassware should not be used in cleaning metal reflectors, since corrosion may be induced in the joints or crevices of the units.

Bowl enameled Mazda lamps may be washed with lukewarm water, but no acids or scouring powders should be used on them. Keep lamp bases out of all washing solutions.

Fig. L shows how the neglect of the luminaries reduces the light output, therefore, all lamps and reflectors should be cleaned at regular and short intervals by wiping off the dust and dirt and should be washed every third or fourth interval under ordinary conditions; however, under abnormal atmospheric conditions as found in steel and iron mills they should be cleaned and washed often.



FIG. J—A building used for storing sheet steel. With two rows of 500-watt units mounted over traveling crane, provides an average illumination of 5 foot-candles.

The voltages of lighting circuits have been properly standardized in two ranges of value; namely, 110, 115, 120 volts and 220, 230, 240 and 250 volts, the first range, and particularly 115 becoming more generally used. The importance of selecting the properly rated lamps to suit the circuit voltage should not be overlooked, the effect of which is shown in Fig. M. Lamps having a rating of 110

volts if used on a circuit voltage of 100 would give only 74 per cent of their candle-power,—a loss of 26 per cent. With only a 3 per cent difference between the voltage of the supply and the rated voltage of the lamps there is a difference of 10 per cent in candlepower, thus the importance of installing the proper rated voltage lamps to suit the line voltage.

Yard and Track Lighting.

Throughout the yards, along tracks and roadways, it is necessary to provide flood lighting, or at least some broadcast illumination, to take care of occasional work and to prevent accidents.

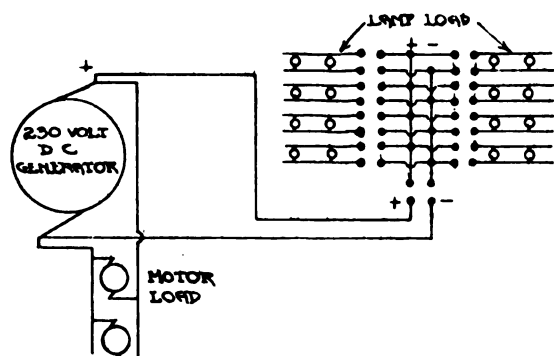
Fig. N illustrates some convenient ways of mounting for this purpose. Standard flood lighting equipment, using either the concentrated filament flood lighting lamps in the 250 and 500-watt sizes or the regular multiple gas-filled Mazda lamps ranging from 300 to 1,000 watts, are recommended. An average wattage of approximately 0.1 watt per square foot of ground area should provide an illumination of 0.5 foot candle, which is the value ordinarily used for good yard lighting. Oppositely directed beams are advisable, as they tend to destroy deep or objectionable shadows.

The lighting of relatively small spaces may be successfully accomplished by using porcelain enameled steel reflectors, both the R. L. M. Dome and angle types. The latter unit mounted along the sides of the buildings, as shown in Fig. N, has several advantages. It is readily accessible for cleaning, and the bent conduit offers a certain amount of flexibility to take up vibration. Particular attention is called to the placing of a reflector on a pole, such as shown in the lower right-hand corner of the figure. By bringing the conduit through the pole the mounting is simple and at the same time firm.

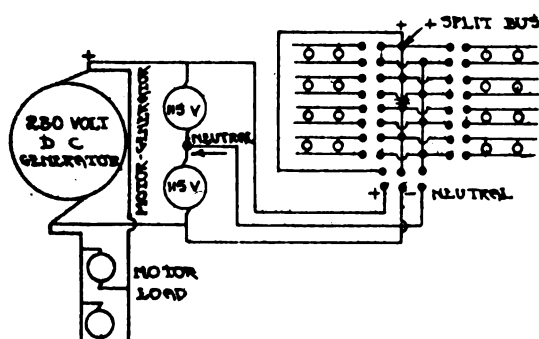
The R. L. M. reflectors should be mounted relatively high for yard lighting. Good practice is to mount such units about 18 to 25 feet above the ground and to space them roughly twice to three times the mounting height. Clear bulb lamps are naturally advised for such service. Here, as with the flood lighting equipment, a wattage of at least 0.1 watt per square foot should be provided.

Unfortunately it seems to be general practice in the steel industry to utilize the power circuits for lighting current. This means that a fluctuating voltage is probable, resulting in an unsteady light and frequently a shortened lamp life. Power and lighting circuits should be separate, especially when the voltage is of the 220-volt range. The advantage of low voltage (110-120 volt) lighting outweighs the old excuse that high voltage lamps reduce lamp theft. Excellent lock sockets and guards are now available, while perhaps the best protection is obtained by employing general lighting with higher wattage lamps which cannot be conveniently used in the workmen's homes.

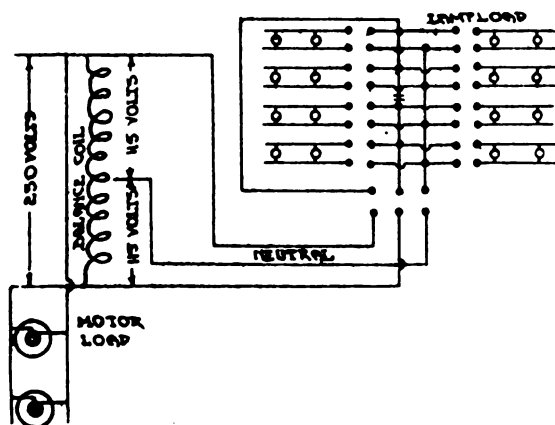
The efficiency of the low voltage lighting lies in the incandescent lamp itself. The 220-volt lamp is more difficult to manufacture and therefore more expensive. The long thin filament is not as rugged as that in the low voltage lamps, is more liable to be broken in handling or in service, and will not produce as much light for the same wattage consumption owing to the cooling effect on the greater surface. There are of necessity more supports over which the filament of the high voltage lamp is stretched, and these also have a cooling effect, lowering the efficiency of the lamp. Another disadvantage of the high voltage is the increased possibility of the lamp arcing between the two lead-in wires. The more efficient operation and lower initial cost of the 110-volt lamp



230 VOLT 2-WIRE D.C. LIGHTING SYSTEM



SAME SYSTEM AS SHOWN ABOVE WITH MOTOR-GENERATOR SET AND NEUTRAL WIRE ADDED, OR BALANCER SET METHOD



3 WIRE A.C. SYSTEM WITH BALANCER COIL

FIG. O—Simple method of changing 220-volt system to 110-volt.

makes this type of lighting on an average 35 per cent cheaper.

Fig. O illustrates simple and economical methods of changing 220-volt systems to 110-volt for lighting service. Ninety per cent of systems which should be converted are d.c. and can be taken care of by installing a motor-generator set and the addition of a neutral wire. This third wire would only be necessary as far as the control panels, the present circuits remaining untouched. Even the two-wire panels, if already installed, can be used by merely splitting a bus as shown and installing a three-pole switch. Either of the two machines of the motor generator set acts as motor or generator, depending upon which side of the line is heavily or lightly loaded. For efficient operation the circuits should be laid out to divide the load as evenly as possible. With an equally balanced load both machines run idle.

In the case of a high voltage a. c. supply it would of course be most economical to step down directly to the 110-volt range, rather than to the 220-volt. If 220-volt transformers are in service the mid tap could be used to obtain the lower voltage. In cases where the current is generated at 220-volt a. c. the use of a balancer coil as shown is recommended. The economy of this apparatus lies in the fact that it carries only the unbalanced load. It is thus important here, as in the case of the d.c. systems, to distribute the load as evenly as possible.

In summing up the foregoing pages it can be stated that it will pay the steel plant owners to give particular attention to their lighting requirements, for the effects of good illumination, both natural and artificial, and of bright and cheerful interior surroundings, include the following:

1. Reductions of accidents.
2. Greater accuracy in workmanship resulting in improved quality of goods.
3. Increased production for same labor cost.
4. Less eye strain.
5. Greater contentment of the workmen.
6. More order and neatness in the plant.
7. Supervision of men made easier.

While it is difficult to place a definite money value on the savings effected in increased production and improved quality by good illumination, it by no means follows that such savings are insignificant or unsubstantial. The plant owner who ignores them neglects his own interests. Other items in the foregoing list, even more difficult to value definitely, are more the less real, taken together they constitute a powerful argument in favor of the best available illumination in the plant.

Tests Show ZR-1's Girders Reliable

**So Light 10-Foot Length Can Be Lifted With Little Finger.
Yet Strong Enough to Hold Row of Men.**

The ability of the frame-work girders of the new navy ship, ZR-1, to carry the loads for which they were designed has been shown by tests conducted at the Bureau of Standards during the past year. In these tests duplicates of the types of girders to be used were subjected to loads sufficient to break them and of the same nature as those which they would be subjected in the airship. In all, 147 such girders were tested.

The results of these tests were remarkably consistent, both as to type of failure and breaking load. Practically all the failures were elastic in character. They depended upon the stiffness of the material, and were not the result of poor work-

manship or defective material. The tests give assurance as to the strength of the principal structural parts of the airship and have furnished data of value in the design of such girders in the future.

The girders were made at the naval aircraft factory in Philadelphia, and are of duralumin, which is an alloy of aluminum and copper. They are remarkably light and strong. A ten-foot length of one of them can be easily lifted on a man's little finger, yet it is so strong that if supported on its ends it can carry all the men who can find room to sit on it. Such lightness is required in airship construction because it takes more than 13 cubic feet of gas to lift each pound of weight, and the ZR-1, which is one of the largest airships in the world and is as long as a dreadnought, will weigh little more than a single Pullman car.

Research and War's Burdens

In order to maintain current standards of living and culture in the face of burdens left by the war, it is imperative that industrial development in future be definitely assured. Since manufacturing advances are won by the introduction into industry of new knowledge, it follows that new knowledge must be systematically sought, and that a portion of the product of industry must be set aside for pursuing the means of further progress.

On the personal side, it calls no less for the proper technical and social education of all grades of workers, together with the fullest utilization of their powers in modern administrative systems affording the most effective co-ordination of personnel.

The organization necessary to meet the two requirements thus broadly distinguished as research and education will be an integral part of the newer type of industrial administration, and the exercise of these functions will provide solutions to many pressing industrial problems.

Julius H. Barnes, president of the Chamber of Commerce of the United States, in an address August 22, at Buffalo, N. Y., before the National Association of Insurance Agents, cited 10 production records that have been established in industry during the last few months. They are:

- The largest pig iron production;
- The largest cotton consumption;
- The largest steel ingot production;
- The largest crude oil production;
- The largest automobile and truck production;
- The largest residential construction;
- The largest production of locomotives;
- The largest volume of rail-order sales;
- The largest volume of retail sales;
- The largest volume of railroad car loadings.

Mr. Barnes also made several significant comparisons of changes that have taken place in the United States since the pre-war year of 1913. The more important of these comparisons are:

The population of the United States has increased 14,000,000 of people, with their enlarged requirements.

The annual national income has increased from \$34,000,000,000 to \$50,000,000,000.

The aggregate savings deposits have increased from \$6,000,000,000 to \$14,000,000,000.

The deposits in national banks have increased from \$6,000,000,000 to \$17,000,000,000.

THE SAFETY CRUSADE

Activities of the Steel Works Club Joliet, Ill.

THE Steel Works Club was dedicated and opened December 21, 1889, by the Joliet Steel Company, Joliet, for its employees and was apparently the pioneer working men's club of any size in America.

The building is a handsome three-story structure of stone and though built in 1889, has been remodeled very little and stands today a tribute to the good judgment of those who planned it.

The object of the club is to promote healthful recreational and social intercourse between members and to afford opportunity for physical, intellectual, scientific and moral culture for the employees of the Illinois Steel Company, American Steel and Wire Company and the Elgin, Joliet and Eastern Railways Company. The membership is confined exclusively to the employees of these three subsidiary companies of the United States Steel Corporation—members paying a nominal fee of \$2.00 a year carry with it all the privileges of the club. It is managed by a board of trustees, a superintendent, board of directors and an associate board of directors.

The club contains pleasant reading rooms with more than sixty periodicals and newspapers, a large billiard room with eight tables, a well-furnished and lighted gymnasium, hand-ball court, a fine bowling alley, a large assembly room seating more than nine hundred people, a bathroom with swimming pool and showers, a kitchen and a large reception room.

The club's work is extended persistently along educational lines. The library provides books of all kinds for home and reference use and many technical and popular periodicals. There are also good books of the latest fiction and foreign books in Swedish, Norwegian, Italian, Slavish, Polish, French, Hungarian and Bohemian.

The class rooms are used by various classes for art, dramatic art, dancing, piano and violin, all of which are conducted on a self-sustaining basis and by teachers who are specialized in their particular vocation.

During the entertainment season of 1922 and 1923,

fifty-one free entertainments were given for the benefit of the members. Every alternate Thursday night a splendid, entertaining as well as educational movie show was presented. These were always very well attended. On the alternate nights department entertainments were given by the various departments of the plants. The programs were rendered by talent from the department.

Dances, banquets, parties, smokers and various meetings are often held in the large auditorium. Athletics play a principal part in the activities of the Steel Works Club. The ball and basketball teams show unusual ability along this line. The boxing and wrestling room is occupied every evening as well as the indoor baseball court, handball court, bowling alleys and the billiard room.

The bathroom and swimming pool is open at all times to the men except on Tuesday, when the wives and eligible daughters of members may have the privilege.

While the club is emphatically a men's club the children are not overlooked. There are gymnasium classes, swimming classes and a juvenile department of the library for the boys and girls.

Every Saturday afternoon during the winter months a junior movie show is given for the boys and girls. It is educational and entertaining with a community sing of patriotic songs at the beginning of the entertainment. At Christmas a party is given. Gifts and candy, as well as an unusual program featuring Santa Claus as the main attraction. There is an average of 600 children attending these programs.

One of the best Child Welfare stations in the State of Illinois is a great attraction for the foreign mothers, as well as many others in this locality.

A troop of Boy Scouts and Girl Scouts is an interesting and an enthusiastic activity.

At the present time there are 2,161 men members and 1,599 complimentary members (wife and eligible



sons and daughters of members), making a total of 3,760.

The Steel Works Club is an educational, social, recreational institution with service, courtesy and Welfare for the members.

Mr. A. H. Shenk is the superintendent in charge of its many useful activities.

Not the least of the recreational activities of the Steel Works Club are the outdoor picnics and gatherings, which feature the summer and fall seasons.

The group of pictures caught by the camera man surely found these kiddies in a happy mood.

Every year brings into greater prominence the value of such undertakings.

Note the Girl Scouts under their volunteer leader,—rough and ready for the healthful days in the sunshine and air; and the boys with their tent pitched and their mess table ready for action. Imagine what this means to tired fathers and busy mothers, whose daily life must be spent in close proximity to crowded cities and great mills.

They form a tie between operating officials and the

workers and their families, which brings a human understanding obtainable in no other way. Spontaneity of play is the best insurance of concentration upon work,—there must be time for both if the steel industry is to attract intelligent young Americans.

Not so many years ago little thought was given to the human needs of industrial workers; there was an adequate surplus of unskilled immigrants, hours of labor were unrestricted and earnings were in proportion to a man's individual capacity to work. The inauguration of the safety campaign changed all this. Safety has come to mean *Welfare*, not alone for the worker himself but for his whole family, and, in fact, the entire dependent community. Such organizations as the Steel Workers' Club will undoubtedly be found among the assets of every large industrial community. Speed the day

when every man who works will have an opportunity of membership in a similar club,—where the future of his sons and their health in mind and body will be as certain as their education.



Twelfth Annual Safety Congress, Buffalo, October 1–5, 1923

THE National Safety Council will open its Twelfth Annual Congress at the Hotel Statler, Buffalo, on October 1st. Joint meetings with the AMERICAN ASSOCIATION OF INDUSTRIAL PHYSICIANS AND SURGEONS and the Annual Safety Conference of the NEW YORK STATE DEPARTMENT OF LABOR.

Safety Drama.

A special feature of the congress this year will be the dramatization of the Safety Movement. Arrangements are being made by which a gripping drama, entitled "Adventure," and written for the occasion by Thomas Wood Stevens, head of the dramatic department of the Carnegie Institute, will be produced every evening during the congress at the Allendale Theater by the Buffalo Players.

No one attending the congress should fail to see this., first, because he will find it well worth while, not only as an interpretation of the heart of the Safety Movement, but also for the thrill in it, and second, because he ought to see whether this or something similar should not be produced in his own community.

Exhibit.

An exhibit dealing with safety education and conceived in a similar dramatic spirit will be found in the Y. M. C. A. Building. This will contain entirely novel and striking features in addition to more concrete, specific material, showing how the school work in safety is being carried on.

First Large Gas-Engine Installation in American Steel Works*

Description and Operating Characteristics of Sixteen Blowing-Engine Units of 2,000 hp. Each, Eight Electric-Generating Units of 1,000 hp. Each and Gas-Cleaning Plants

By E. P. COLEMAN†

PART I.

AT THE Buffalo works of the Lackawanna Steel Company is located the first gas-engine power plant to be operated in this country with blast-furnace gas.

As far as can be learned, the selection of the type of engine was made in 1900, based on extended observation by a committee of the working of blast furnace gas-power plants in Europe. The types observed were the Cockerill, Otto, Oechelhaueser, and Koerting. The Oechelhaueser engine was disregarded on

The recent acquisition of Lackawanna Steel Company, by the Bethlehem Steel organization, and the consequent program of expansion and improvement draws attention to this pioneer installation of gas-blowing and gas-electric engines.

When installed they created much comment and much criticism,—emphasized no doubt by the magnitude of the operation. After some twenty years of heavy service, and with but slight modification in their original design they are about to give way to the most modern and largest gas engines designed and manufactured by their new owners.

So great is the historical value of this original achievement that criticisms and comments which followed the presentation of Mr. Coleman's paper may be read with interest.

account of the crank shaft design and the four-stroke cycle engines were not favorably considered on account of exhaust valve troubles which did not seem to have been mastered at that time. The engines were built by the De La Verge Machine Company, New York, after designs by the firm of Koerting Brothers, Hanover, Germany.‡

At this plant 12,000 to 15,000 net hp. is normally developed by gas engines operated with blast-furnace gas, the greater portion for blowing the furnaces. There are sixteen blowing engines, each rated at 2,000 ihp., and eight electric power units, each consisting

of a gas engine rated at 1,000 ihp., direct-connected to a 500-kw. generator. Four of these units generate direct current at 250 volts, and the other four generate three-phase 25-cycle alternating current at 440 volts. All of these gas engines are of the two-stroke cycle type, equipped with twin cylinders and cranks spaced 90 deg. apart. A brief general description of the plant used in developing this power will first be given, followed by a more detailed description of the various parts.

General Description of Plant.

There are six blast furnaces in a line extending approximately north and south. These furnaces are grouped in pairs, each pair forming a unit with reference to the arrangement of its stoves, ore bins, gas plant, and other auxiliaries. A seventh furnace not shown is now in operation, but as all of the excess gas from this furnace is burned under boilers, it does not concern the subject under consideration.

The blowing engines using gas are located in the two buildings, No. 2 and No. 3 blowing-engine houses. The engines in blowing-engine house No. 2 furnish air for furnaces 3 and 4. Furnaces 5 and 6 are supplied with air by the engines in blowing-engine house No. 3. The air for furnaces 1 and 2 is usually supplied by steam engines located in the north end of blowing-engine house No. 2. Considerable flexibility is secured by means of cross connections, with valves, between the various cold blast mains. The gas-driven electric-generator units are located in the south end of power house No. 1, situated east of blowing-engine house No. 2.

The generation of power at this plant requires three principal processes: the production of the gas by the furnaces; the preparation of the gas for use in the gas engines, involving cooling, cleaning and drying; and the development of power by combustion of the gas in the motor cylinders.

The general process of preparing the gas for use in the motor cylinders is as follows: the gas leaving the furnace top passes through large downcomer pipes to the dust catcher, where the heavier portion of the dirt is deposited under the action of gravity. From the dust catcher, portions of the gas pass through pipe mains respectively to the hot stoves, the boilers, and the gas engines. That portion used by the gas engines is cooled and partially cleaned by means of water sprays in the pipes and chambers through which the gas passes; after which it is further cleaned by passing through centrifugal fans into which water is also sprayed. From the fans the gas passes through separators which remove the entrained moisture and its entrained dirt, and thence under a few ounces of pressure (above atmosphere) to the engine houses.

*Presented at the annual meeting, New York City, 1910, of the American Society Mechanical Engineers.

†Lackawanna Steel Company, Buffalo, N. Y. Member of the A. S. M. E.

‡In the collection and tabulation of various of these data, and other matters, the author begs to acknowledge the valuable assistance of the following gentlemen: Hugh Boyd, E. E. Kiger, George Conlee, F. C. Baker, F. L. Palmer, F. C. Taylor, R. R. Streeter and Harry Thompson, all of whom are, or have been, members of the engineering department of the Lackawanna Steel Company. The experience of the author at this plant dates from the early part of 1906.

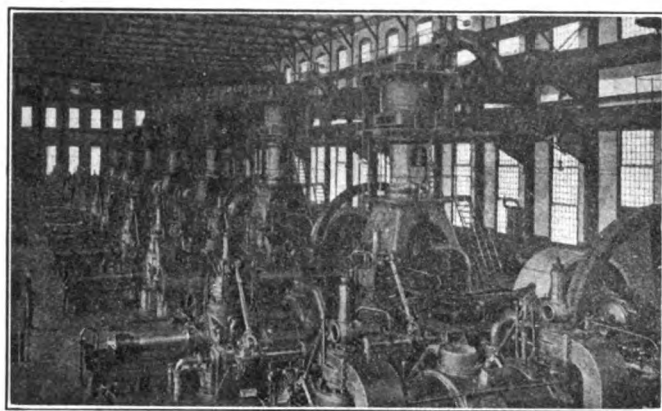
That portion of gas going to the stoves and boilers receives no further cleaning after leaving the dust catcher.

There are eight blowing engines in each blowing-engine house, each rated by the makers at 2,000 hp. In the power house are eight engines rated at 1,000 hp. each.

Furnaces.

The six blast furnaces under consideration produce about 2,600 long tons of iron per 24 hr., or about 108 tons per hr. The gas amounts to about 150,000 cu. ft. per ton of iron, or say about 16,000,000 cu. ft. per hr., or more from the six furnaces. Approximately 2,500,000 cu. ft. per hr. is used for the gas-engine plant, the remainder being burned in the hot-blast stoves and under the boilers.

Furnaces 1 and 2, located at the northern end, are smaller than the others, being rated at about 300 tons each per 24 hr. The main dimensions are: hearth



Koerting gas-blowing engines.

diameter, 11 ft.; diameter of bosh, 17 ft.; height, 87 ft. There are three downcomers of steel plate construction, each 50 in. in diameter and lined with fire brick to 45 in. diameter. These unite at the top of the dust catcher, which is 20 ft. diameter of shell, and equipped with conical top and bottom. The dust catcher is lined to about 18 ft. 3 in. inside diameter and is about 29 ft. deep from inlet opening to dust valve at bottom. These furnaces operate at about their rating of 300 tons each per day.

Furnaces 3, 4, 5 and 6 each make about 500 tons of iron per day. Furnaces 3, 4 and 5 are alike in general dimensions. The hearth is 15 ft. 9 in. diameter; bosh, 22 ft. 9 in. diameter; and the height above hearth is 94 ft. Furnace 6 has corresponding diameters of 15 ft. and 22 ft. and is 94 ft. high.

Three downcomers of steel plate, each 6 ft. 6 in. in diameter, lined to 5 ft. 9 in. inside diameter, take the gas to the dust catcher, which is 32 ft. in diameter, lined with 9-in. fire brick, equipped with conical top and bottom, and about 39 ft. deep from top gas inlet to dust valve at bottom of hopper.

All of the dust catchers are provided with a suspended partition or baffle wall of firebrick, cutting off direct passage of gas from inlet to outlet; the gas having to pass under this wall and up to the outlet. The location of these furnaces is shown in Fig. 1.

Gas Washers.

There is a gas-cleaning plant at each pair of fur-

naces consisting of chambers equipped with water sprays for cooling the gas and washing out a portion of the dirt, centrifugal fans also provided with water sprays, separators for removing the entrained water, and the necessary valves and piping.

The 70-in. pipe connecting the dust catchers to the fans is about 236 ft. in length, the total travel of the gas from dust catcher to fan being about 123 ft. Located in this piping are 99 water sprays for cooling the gas on its way to the fan washers. These spray nozzles are located at the axis of the pipe, about 3 ft. 6 in. apart, and discharge a cone-shaped spray into and against the flowing stream of gas. The sprays are supplied from a 3-in. header through 1-in. pipe connections and each spray consumes about 8 gal. of water per min. The water drains first into the 8-ft. tanks and from thence through a seal into tank cars beneath, where the dirt is deposited and the water passes off from an overflow into the general drainage system.

The four fans are housed in a steel building enclosed with corrugated steel sides and roofing and open for light and ventilation on all sides.

The fans are very similar in general features to ordinary centrifugal ventilating fans. The wheels are 6 ft. 11 in. in diameter. There are 8 blades, each 15½ in. wide at the inner end and 13 in. wide at the tip, carried on tee-iron arms set in a cast-iron hub. The wheel is split, and the casing of steel plate is arranged for convenient access to and removal of the wheel.

Each fan is driven by a 75-hp. electric motor direct-connected to the fan by means of a flexible coupling. Three of these motors utilize alternating current and the remaining motor is of the direct-current type. These motors operate at about 500 rpm., the input being normally about 55 hp. each. Control is by means of a switchboard located in a small brick building just outside the fan house.

The four cooling towers are carried on a structural platform about 30 ft. square and 18½ ft. above yard level. This elevation provides clearance for the mud cars placed beneath to receive the drainage from the bottom connections. The connections between the towers are 8 ft. in diameter and the travel of the gas is up and down in alternate towers. Each tower is provided with a hopper bottom and pipe seal having connection with a common drain pipe which delivers the discharge of all four towers to the tank cars beneath. Towers A and B are further provided with emergency seal drains at a higher level. These emergency seals are normally idle, but should the bottom drain become clogged the tower will then drain through the emergency seal. Tower A is further provided with a suspended steel plate baffle in front of the 96-in. inlet opening. This arrangement when filled with water to the required height acts as a valve to shut off communication between the towers and the dry-dust catcher, a sealed overflow maintaining the proper water level when desired. The first tower is equipped with about 30 sprays, the second has 35, and the third and fourth about 20 to 25 sprays each. The sprays are placed in five circumferential rows, 6 ft. apart vertically. The lower row is about 20 ft. from base of tower. These towers are like those shown in Fig. 5 for furnaces 5 and 6. Several of the illustrations are of the gas washing plant for furnaces 5 and 6 which are similar to that of furnace 3 and 4.

The standard nozzle is of brass throughout. The shell has a $2\frac{1}{2}$ -in. external pipe thread which screws into a flange riveted to the shell of the tower. The helical passage produces a whirling cone-shaped spray of about 90 deg., and 6 to 10 ft. diameter. The $1\frac{1}{2}$ -in. plug provides convenient access to the spindle for cleaning. The $1\frac{1}{2}$ -in. plug provides convenient access to the spindle for cleaning. These sprays use about 7 gal. per min. at the average pressure carried.

There are eight centrifugal fans made by the Buffalo Forge Company. The wheels are of $\frac{1}{4}$ -in. plate, 7 ft. 1 in. in diameter, having eight blades each $29\frac{1}{2}$ in. wide at the inner end, and $27\frac{1}{2}$ in. wide at the tip. Central opening of wheel is 40 in. in diameter.

The casing is of cast iron and of the double suction type. It is made in sections, with machined joints bolted together for removal of wheel. Manholes are provided for cleaning and inspection. Each branch of the suction connection is rectangular, 20 in. by 50 in., opening into the fan through a 36-in. diameter inlet. The bottom discharge connection is 40 in. by 36 in.

The wheel shaft, of $6\frac{1}{2}$ -in. diameter, is direct-connected through a flexible coupling to a 100-hp. motor operating at 480 rpm. Six of these motors utilize alternating current, the other two being for direct current. The two types are used so that should there be an accident to either circuit, the motors connected to the remaining circuit will continue to operate and keep a part of the engines running until the necessary corrections can be made.

Water is thrown into each fan through 16 spray nozzles. Eight of these discharge into the central inlet openings, four on each side; the other eight discharge into the fan through the upper half of its periphery. The sprays are fed by four $1\frac{1}{2}$ -in. lines connected to a 6-in. header extending the full length of the building, over the fans. Each spray connection is a $\frac{3}{4}$ -in. pipe. The water for the fan sprays is taken from the waste of bosh cooling water from the furnace, which overflows from a standpipe, a portion under the necessary head going to the fans.

Blowing-Engine Houses.

The blowing engines are located in two buildings, blowing-engine houses Nos. 2 and 3, each substantially alike in design and arrangement. Each blowing-engine house contains eight air-compressing units, each unit having a capacity of about 20,000 cu. ft. of free air per min, when operating at 65 rpm.

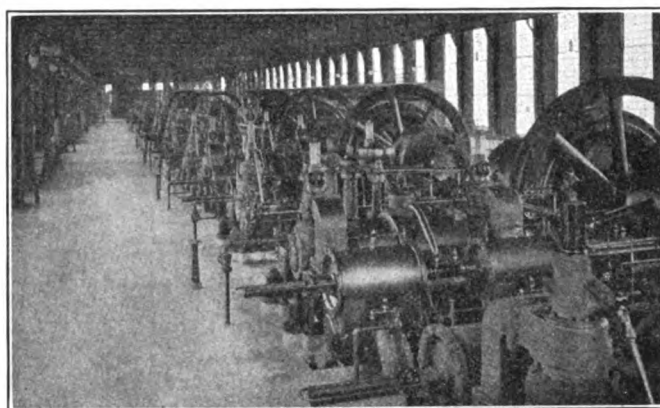
The gas engines, built by the De La Vergne Machine Company of New York, are coupled to vertical blowing engines built by the Southwark Foundry and Machine Company of Philadelphia.

Each building is 425 ft. long. A basement 10 ft. deep provides space for piping, oiling system, etc. A steel skeleton frame supports the roof and runways for a 35-ton electric traveling crane. The walls are of brick, and the roof of corrugated iron sheathed inside with wood. Air enters through louvers located in the east wall at intervals of $12\frac{1}{2}$ ft. The flooring is of $\frac{5}{16}$ -in. checkered steel plate laid on 10-in. beams. Two cold-blast mains, one for each furnace, extend the entire length of building, and arrangements are such that any of the eight engines can deliver to either of the two cold-blast mains. The piping is so arranged that the north engine in blowing-engine

house No. 2 can deliver to furnaces 1, 2, or 7. There is also an auxiliary blast main connecting blowing-engine houses Nos. 2 and 3 in such manner that steam-driven blowing engines may deliver to any one of the seven furnaces, when required.

The cooling water for the engines is taken from a 12-in. main extending the full length of the building on the side of the basement. A 10-in. reserve main is installed on the west side. Opposite each engine is located an 8-in. connection with valve. From this connection a 6-in. branch leads to each side of the engine. The supply of water for each engine is thus controlled by one valve.

As originally installed, cylinders, pistons and muffling sprays were all supplied with water through individual connections, each wasting to a sewer. The system has since been modified such that the water passes through piston, cylinder heads, cylinder jackets



Koerting gas-electric engines.

and muffling sprays in the order named. A small portion of the water only is used by the muffling sprays.

Thermometers are placed to indicate the temperatures of water leaving the piston and cylinder jackets. The jacket water leaving each cylinder head discharges upward through a vertical pipe provided with a return-bend discharge nozzle. The water leaving the nozzle discharges downward into a funnel leading to the cylinder jacket, the stream thus being in full view of the operator.

Compressed air for starting is supplied through a 5-in. branch from a 6-in. main delivering air from power house No. 1. The 5-in. connection divides into two $3\frac{1}{2}$ -in. branches, one to each side of the engine where it connects with the starting valve.

Oiling System.

An oiling system of the gravity type is installed at each blowing-engine house. Two 500-gal. storage tanks are located near the roof from which the oil is piped to the sight-feed connections on the engines. A complete system of drip pans and oil catchers is provided at the engines. From the pans the oil drains to the basement, and passes first through a gravity separating tank where most of the water is removed. The oil then flows over a heating device where its temperature is raised to about 120 deg. F. and it then passes through settling tanks and wire boxes, where the remaining water and nearly all of the suspended matter are deposited under the action of gravity. From the weir boxes the oil passes into White Star

filters, and thence by means of a duplex steam pump to the storage tanks located near the roof.

The above description applies to the system used for supplying oil to parts of the engine where the oil is but slightly contaminated by foreign matter. At certain other points of lubrication, such as the gas pump and motor piston rods, etc., the return oil is contaminated to a considerable degree by flue dirt. A separate system very similar in principal to the one already described is installed to take care of these parts.

The buildings are heated by means of the forced circulation of hot water through radiation piping. The piping extends entirely around the building and the water which is heated by exhaust steam, is circulated by means of a centrifugal pump.

Power House.

Eight units for developing electric power, each rated at 1,000 ihp., are located at the south end of power house No. 1 and occupy a space 350 ft. long. The engines are direct connected to 500-kw generators, four of direct current, 250 volts, and four of three-phase 25-cycle alternating current, 440 volts. The total length of the building is 725 ft., the width 77 ft. and the height from the floor line to the bottom chord of the roof truss 35 ft. A steel skeleton frame supports the roof and crane runways. A basement 8 ft. deep is provided and a concrete mat, on piling 83 ft. wide by $4\frac{1}{2}$ ft. thick, supports the building and machinery. An interior view of the power house is shown in the reprint.

The floor is of concrete reinforced with expanded metal, resting on I-beams. Cast-iron gratings between the engines ventilate the basement.

The switchboard is placed on a platform 213 ft. long at the east side of the building. A controlling panel is provided for each generating unit. Numerous feeder panels control the various mill circuits. The alternating-current switches are located at the south end of the board, and the direct-current control at the north end.

The engines exhaust into the main drainage tunnel and a steel stack 5 ft. in diameter and 60 ft. high carries away the gases and vapor.

Each engine takes gas from a 30-in. main outside the west wall of the building through an 18-in. connection controlled by a gate valve; this 18-in. connection divides into two branches, one going to each gas pump. A throttle valve controlled by a Tolle governor and placed as close as possible to the valve chest of its respective gas pump, is located in each of these branches.

The air pump draws its supply from the basement. Compressed air for starting is provided through a 6-in. main extending the entire length of the plant. There is a 4-in. branch at each engine.

The cooling water is supplied from the general yard service through a 6-in. main with branches at each engine.

Each motor cylinder is provided with a separate exhaust pipe of 16-in. diameter exhausting directly into the tunnel. Water is sprayed into the pipe to cool and muffle the exhaust.

Koerting Two-Stroke Cycle Engines.

The engines were designed by the firm of Koerting

Brothers, Hanover, Germany, and were built by the De La Vergne Machine Company, New York. They are of the two-stroke cycle double-acting twin-cylinder type.

The blowing-engine units have motor cylinders $38\frac{1}{2}$ in. in diameter by 60-in. stroke, and occupy a floor space of 40 ft. by 52 ft. The engines for electric generating have cylinders $24\frac{3}{4}$ in. in diameter by $43\frac{3}{8}$ -in. stroke and occupy a floor space of 32 ft. by 36 ft.

The cycle of operation with reference to the motor cylinder is as follows: Gas and air are compressed in separate pump cylinders to a pressure of about 10 lb. per sq. in. above atmosphere. The gas and air meet in the mixing chamber above the inlet valve of the motor cylinder. During the period when the motor piston is at and near the outer end of its stroke, the inlet valve opens, admitting first the scavenging air and second the mixture to the motor cylinder. During the return stroke of the piston the charge is compressed to a final pressure of about 150 lb. gage.

Ignition by electric spark takes place somewhat prior to the completion of the compression stroke. Near the end of the expansion stroke, the piston uncovers the exhaust ports through the cylinder walls. The opening of the inlet valve occurs very soon thereafter, and the new incoming charge forces the burned gases out through the exhaust ports, completing the cycle.

The general plan and elevation of the 2,000-hp. engine is shown by assembly drawings in the reprint. The smaller engines are very similar in general design.

Each unit is composed of two separate engines, each complete in itself with the exception that the crankshaft is common to both.

The main frame for each side is composed of two heavy cast-iron box girders. The motor cylinder is supported on and between these at one end. The shaft bearings are formed in the other end of the frame.

At one side are the gas and air-pump cylinders. The two pistons are mounted on a single piston rod and driven by an over-hung crank on the outer end of the crankshaft.

The pump valves are of the piston type, smooth cylinders without packing of any kind, and are driven by eccentrics on the crankshaft. The induction valve for the gas pump is open during about 145 per cent of its suction stroke; that is to say, during the entire suction stroke as well as the first 45 per cent of the discharge stroke. The air pump discharges during nearly its entire stroke, the object being to provide scavenging air for the motor cylinder prior to the entrance of the mixture. The gas and air pass from their respective pumps through ducts to a mixing chamber above the motor inlet valve. The prior discharge action of the air is intended to force the gas column back into its duct, prior to the opening of the motor inlets, in such manner that scavenging air is provided in advance of the mixture.

The motor cylinders are of cast iron in one piece with water jacket and exhaust passage. The cylinder heads are of cast iron with water jackets and are provided with an expansion joint.

(Continued in October.)

Youngstown S. and T. Reorganizes

Twenty-Three Years of Steady Growth Reflects Conservative Leadership—A Training School for Executives

THE Youngstown Sheet & Tube Company is now well along toward the close of the first quarter century of its existence, and during 19 of the 23 years of it J. A. Campbell has been president of its great organization.

During these years the company has expanded from an almost inconsequential little concern at East Youngstown to one of world-wide importance, employing at capacity upwards of 25,000 men, and with property and interests throughout the country and in foreign lands.

Its various holdings are conservatively valued at \$250,000,000. It is rated as one of the most highly efficient and firmly entrenched units of the iron and steel industry.

There are those who say that Youngstown Sheet & Tube has only started to grow. It can produce annually over 3,000,000 tons of material, 6 per cent of the aggregate capacity of the entire country. Big things are evidently in store for Youngstown Sheet & Tube if it measures up to expectations.

Its organization is alive with young blood, yet is made up of men thoroughly trained for the big work confronting it. The great corporation will carry the name of Youngstown to the four corners of the world. It is the city's greatest single asset.

Beginning in 1900.

Youngstown Sheet & Tube was organized in 1900 with an initial capital of but \$600,000. A small plant to make iron sheets and pipe was planned. Its original name was the Youngstown Iron, Sheet & Tube Company, but it became a steel maker and the word "iron" was dropped.

The first units of the plant were erected in 1901 and 1902, consisting of 15 double puddle furnaces, a muck-bar mill, a skelp mill, three tube mills and six sheet mills. Total output in 1903 was 32,000 tons of sheets and 90,000 tons of pipe, all iron.

Following the accession of J. A. Campbell to the presidency in 1904, a Bessemer steel plant was added in 1905 and 1906. The open hearth was built in 1912. In 1908 the first two of the present 19 blast furnaces owned and operated by the company were constructed.

From that time on the company has grown and expanded by leaps and bounds. Next to the United States Steel Corporation it is the greatest maker of steel pipe in America. It operates 43 sheet mills, being one of the greatest producers of that product next to United States Steel. It also has large capacity for wire, nails, merchant steel bars, steel plates as well as pig iron for its own use and the merchant market, semi-finished steel and other products.

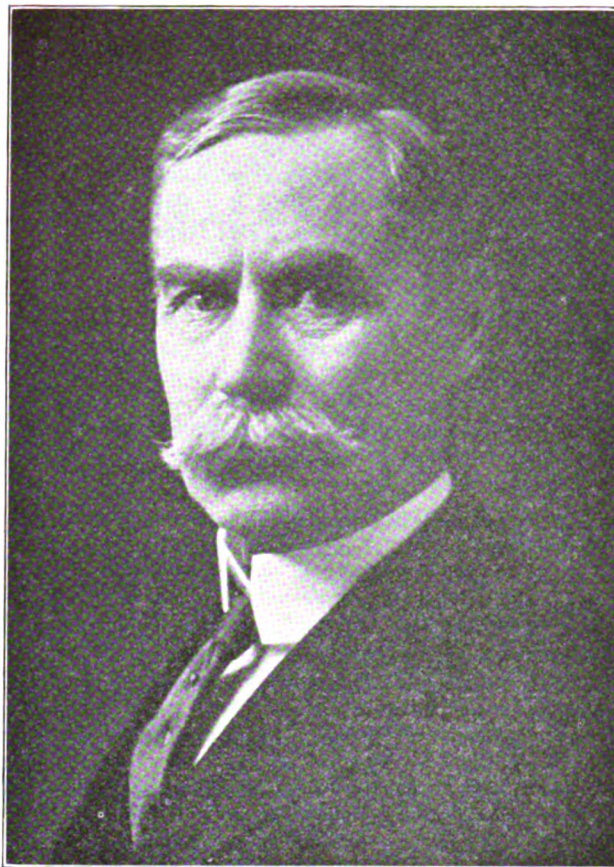
Its first plant purchased was that of the Morgan Spring Company, at Struthers, in 1909. This it developed into its rod and wire department.

In 1911 it purchased the plant of the Western Conduit & Manufacturing Company, at Harvey, Ill. The ensuing year the equipment was removed to Youngstown and operated as the Western Conduit Company, a subsidiary. The Western Conduit Company was dissolved in 1917, and operated thereafter as a department.

In 1916 the two blast furnaces of the Andrews &

Hitchcock Iron Company, at Hubbard, were purchased. Along with these units came valuable iron ore properties.

The first really great plant purchase of Youngstown Sheet & Tube was that of the Brier Hill Steel Company in 1922. Assets of approximately \$40,000,000 were thereby transferred to Youngstown Sheet & Tube. This



PRES. JAMES A. CAMPBELL

was followed by purchase more recently of the great property of the Steel & Tube Company of America at a price approximately \$55,000,000.

By these two transactions properties with an actual value of far more than \$100,000,000 were acquired by Youngstown Sheet & Tube.

The transactions required great increases in the company's capital. Instead of the original \$600,000 capital it has now outstanding \$75,000,000 of bonds and notes, \$14,250,000 of preferred stock and 987,606 shares of no-par value common stock.

Other Interests.

In addition to these purchases of manufacturing properties the company has acquired large coal, iron ore, and zinc holdings, making it self-contained for many years with these important raw materials. Its coal mine at Nemacolin, Pa., is the largest single coal working on the continent with a daily production capacity of 6,000 tons.

Large by-product coke and benzol plants have been built or acquired. Youngstown Sheet & Tube has expended millions in housing for its employes, a fine plant hospital has been erected at East Youngstown and night schools are conducted. Its safety appliances are of the highest character. The corporation's aim has been to leave nothing undone that contributes to employes' welfare and betterment.

An employes' representation plan was introduced a few years ago. Through it employes are given an opportunity of discussing with the management matters concerning conditions of employment.

Taking care of its employes as well as making iron and steel profitably have always been matters of equal consideration with Youngstown Sheet & Tube. This fact may be the answer to why Youngstown Sheet & Tube has grown so rapidly and prospered so greatly.

Sheet & Tube Company Grows All Its Own Big Men.

One source of pride with the Youngstown Sheet & Tube Company is that it grows from within.

The management of the Sheet & Tube today includes only men who founded the company, who came to it in its younger and obscure days or who started in as boys and grew up with the concern.

Its president, J. A. Campbell, has been with it since the beginning and has been its head for almost a score of years. His career as an iron maker is well known. H. G. Dalton, who remains as vice president in the reorganization that took place recently, was among the founders of the concern. Here is the record of those who profited by the reorganization:

President—J. A. Campbell.

First Vice President—H. G. Dalton.

Vice Presidents—C. S. Robinson, W. C. Reilly and Frank Purnell.

Treasurer and Assistant Secretary—William J. Morris.

Secretary and Assistant Treasurer—Walter E. Meub.

Youngstown District Manager—Elmer T. McCleary.

General Manager of Sales—Walter E. Watson.

Assistant Secretary—F. R. Wahl.

Comptroller—W. N. McDonald.

General Counsel—L. A. Manchester.

Assistant General Counsel—J. C. Argetsinger.

Charles Snelling Robinson, vice president in charge of operations, has been one of the strong figures in the Youngstown Sheet & Tube Company since coming into the organization in 1906. He comes of a family of iron and steel makers and engineers and the constant mechanical preparedness of his company is a tribute to the success with which he has measured up to the traditions of his family.

Immediately previous to coming to Youngstown he was for seven years general manager of the Colorado Fuel & Iron Company. He had previously been with the Illinois Steel Company, now a unit of the United States Steel Corporation.

He is known as one of the quiet men of the Youngstown Sheet & Tube official family, almost as little disposed to be seen as heard. He has wide affiliation with technical, engineering and iron and steel organizations of this country and Europe, and is rated as one of the "big men" of the industry.

F. C. Reilly, new vice president of the Youngstown Sheet & Tube Company began his career in the iron busi-

ness with Brown, Bonnell & Company when a mere boy.

Later Mr Reilly became identified with the Mahoning Valley Iron Company as a bookkeeper when that company was managed by H. O. Bonnell. When the Republic Iron & Steel Company was formed in 1899 he was head bookkeeper for the Mahoning Valley company and had much to do with the transfer of that concern to the merger.

With the transfer made, James A. Campbell, then superintendent of the "Valley" mill, was named district superintendent for the Republic and named Mr. Reilly as his assistant. Together they were associated with Col. George D. Wick in the organization of the Youngstown Iron, Sheet & Tube Company late in 1900, Mr. Reilly becoming auditor of the new company. With the plant actually in operation he was named general superintendent, a position he has since held.

Frank Purnell, the new executive vice president, is one of the most widely experienced steel salesman in the industry, started as a hall boy for the company in its early days. He was transferred to the sales department. There began the career which has already been so notable and which bids fair to have yet further achievements.

During the war Mr. Purnell went to Washington as assistant to J. Leonard Replogle in charge of the steel section of the war industries board. At the conclusion of that service he went to New York, where he became an officer of the Consolidated Steel Corporation, the big export subsidiary of the independents. On its dissolution about a year ago he was named vice president in charge of the Bethlehem Steel Export Corporation, the export subsidiary of the Bethlehem Steel Corporation. In that capacity he was known as one of the high-priced steel salesmen of the country.

He is now coming back to Youngstown at the invitation of President Campbell of Youngstown Sheet & Tube. Except for the time he was recently with the Bethlehem Steel Corporation, he has always been looked on as a Sheet & Tube man.

His experience bringing him in contact with the world steel situation will undoubtedly be a valuable asset to the big local independent and will be in keeping with the broadening of Sheet & Tube to one of the big factors in the world steel markets.

Elmer T. McCleary, Youngstown district manager, came to the Youngstown Sheet & Tube Company in 1906 as a chemist. He had previously been with the Carnegie Steel Company in a similar capacity in the blast furnace department. Three years later he was made assistant superintendent of blast furnaces and steel department. In 1912 he became assistant general superintendent of the plant.

He is one of the quiet men who do things in the Sheet & Tube organization. Advancement has always been with him but new opportunity to demonstrate his ability.

Mr. McCleary graduated from Pennsylvania State College in 1901. He had specialized there in chemistry and metallurgy. He is a member of important national technical organizations.

William J. Morris, treasurer and assistant secretary, also one of the youngsters in the Youngstown Sheet & Tube official family, does not hold his official titles by virtue of any pull.

He worked his way up from cost clerk in 1915. In recent financing in connection with the Sheet & Tube purchase of iron and steel properties, he is reported to have won high recognition from New York bankers. The

financing plan, finally adopted and one highly advantageous to his company, is reported to have been largely evolved by him.

After graduating from Rayen School Mr. Morris was first with the Commercial National Bank and later for a short time with the G. M. McKelvey Company. He next went to Republic Iron & Steel as time keeper, coming to Youngstown Sheet & Tube 18 years ago.

Mr. Morris is in close touch with the affairs of his company, a hard worker and a speedy one, too.

Walter E. Meub, secretary and assistant treasurer and long a right-hand man to President J. A. Campbell, is one of the youngsters in the new official family of the Youngstown Sheet & Tube Company.

A few years ago he was chief clerk, in that capacity he frequently came in close touch with President Campbell. He was soon made the latter's secretary. Other advancements followed.

His numerous duties and responsibilities soon made "See Walter" a frequently heard expression about the offices of the company.

As secretary to the president he was rated as one of the most capable in the entire country. The most unwarranted callers were always treated with a tact that almost made them feel complimented at being turned back.

Diplomacy though, is not his only forte. Much of the important buying of the company is done by Mr. Meub.

For eight years before going to the Youngstown Sheet & Tube Company in 1909 he was with the Erie Railroad.

Walter E. Watson, new general sales manager of Youngstown Sheet & Tube and formerly assistant general sales manager, has been with the company for 10 years. He came to it in 1913 from the La Belle Iron Works Company, with which company he was assistant manager of sales. Previously he had been in the sales department of the National Tube Company, subsidiary of the United States Steel Corporation. His experience as a steel salesman has been broad, especially in the line of steel tubing, which is the chief product of the greater Youngstown Sheet & Tube Company.

Mr. Watson is an official in several of the subsidiary companies of Sheet & Tube. He has been so closely identified with the company in various ways and prominent in its counsels that he is well fitted to assume his new responsibilities.

Roy M. Welch, now secretary to President J. A. Campbell, and for several years "assistant to the president, with headquarters at the plant, is one of the hand-picked men of the Sheet & Tube executive.

As special agent for the company several years ago his work brought him in contact with President Campbell and won his commendation. He was soon named his assistant at the plant and recently made his right-hand man as secretary.

Mr. Welch started with the Ohio Steel Company, now the Ohio Works of the Carnegie Steel Company, as a laborer and clerk. He remained with the concern until he went to Youngstown Sheet & Tube in 1901 as store-keeper. Later he was assistant purchasing agent, then assistant to Vice President C. S. Robinson.

Mr. Welch is another of the men in the Youngstown Sheet & Tube organization who has made his way forward by virtue of hard honest and effective service.

Leroy A. Manchester, general counsel for the Youngstown Sheet & Tube Company, is comparatively a newcomer in that organization. He arrived in time, though, to guide the corporation through the legal com-

plications of its most momentous steps, involving the purchase of properties worth in the aggregate upwards of \$150,000,000.

He became identified with the law firm of Arrel, Wilson and Harrington here in 1906 and a year later a member of the firm of Hine, Kennedy, Manchester and Robinson. The senior member of that firm was for years the general counsel of Youngstown Sheet & Tube.

In this way Mr. Manchester came under the notice of President J. A. Campbell of Youngstown Sheet & Tube, who recognized in the young lawyer the kind of a man needed for his corporation. For several years he has devoted all his time to Youngstown Sheet & Tube affairs.

William N. McDonald has been comptroller of the company since August 1, 1920. Shortly before that time he came to the Youngstown Sheet and Tube Company as a representative of the Price-Waterhouse Company, expert accountants. His work attracted the attention of President Campbell and he was added to the organization.

Before becoming a member of the Youngstown Sheet & Tube organization Mr. McDonald was identified with certain of the subsidiaries of the National City Bank of New York in New York. He was also in South America with National City Bank subsidiaries.

As comptroller Mr. McDonald is in charge of all accounting and in these days of super-taxation the duty is one of the most delicate of corporation official activities.

Aid for Italian Iron and Steel Industry

Reduction of Duty on Pig and Abolition of That on Scrap Should Materially Assist Steel Production.

On July 10 the present tariff was approved by the Italian Chamber of Deputies with, however, a number of changes as compared with the original schedules, Commercial Attache H. C. MacLean reports to the Department of Commerce. Many of the rates that have been modified cover commodities for which special conventional duties had already been established by commercial treaties entered into with France, Switzerland and Austria. This is especially true in the case of iron and steel products and owing to the fact that the reduction from the old general duties has reduced the benefit derived from the treaty concessions, a special list of new conventional duties on a number of articles has been drawn up which will apply to nations receiving most-favored nation treatment, which includes the United States.

In general small reductions have been made in many co-efficients of increase on iron and steel products. The duty on cast iron scrap has been eliminated and the co-efficient applying to pig iron has been reduced from 2.5 to 1.5, making the duty now lire 3.125 per metric quintal instead of lire 4.375 per quintal. A similar change has been made in the co-efficient applying to spiegeleisen containing 15 to 25 per cent manganese, while a co-efficient of .6 has been applied to ferro-alloys, on some of which the co-efficient was formerly 1 and on others .5.

The reduction of tariff on pig iron should facilitate the running of the steel plants, and now that cast iron scrap is free of duty it will be more readily available for conversion into pig iron in the electric furnaces.

Italy is now equipped with nine powerful coke blast furnaces, and 113 electric steel furnaces of large and medium capacity and 60 small ones. Production in 1922, according to the Association of Metallurgical Industrialists, amounted to 943,000 tons, including national pig iron. The total number of employes and workmen engaged by iron and steel-working plants is about 100,000, and the capital invested is estimated at \$100,000,000.

Heavy Alternating Current Busses for Furnaces and Synchronous Converters

A Practical Discussion of the Difficulties Encountered Due to Magnetic Effects in Carrying Heavy Alternating Currents Short Distances in Industrial Plants

By J. L. McK. YARDLEY*

PART I.

THE magnetic field set up by the current in different parts of the conductor reacts upon the current. The current always seeks the path of least impedance, therefore it distributes in such manner as will decrease the magnetic reaction of the elements of current one on the other and thus decrease the reactance voltage. An unequal distribution of current increases the ohmic resistance drop. The final distribution of current is such that it strikes a compromise between decreasing the reactance and increasing the ohmic drops in voltage. As reactance increases with frequency it is evident that the higher the frequency the greater the current will depart from uniform distribution within the conductor in striking the compromise between reactance and resistance. This departure, which is ordinarily spoken of as "skin effect," is consequently more pronounced at 50 and 60 cycles than at 25 cycles.

With solid cylindrical copper conductors of one-half in. or even one in. in diameter the skin effect at 25 cycles is negligible, but with a two-in. conductor

effect" factors. The factor for aluminium conductors is slightly less than for copper of the same cross section. For copper and aluminum sections of equal resistance to direct current the increase in resistance to alternating current is practically the same.

The shape of conductor, as well as the sectional area, must, therefore be considered when heavy alternating currents are to be transmitted. For a given cross section area of conductors, as far as effective resistance is concerned, the poorest solid section form is round; and the best, where the return circuit is near, is a thin, flat sheet. If a solid cylindrical conductor be rolled into a sheet and then formed into a thin walled tube of the same cross section area, the effective resistance of the tube will be considerably less than that of the solid conductor. By separating a solid conductor into sections with ventilating spaces between the current distribution of effective resistance is not affected, but the current-carrying capacity is increased, due to the greater radiating surface provided.

The elements of current in any conductor or set of conductors tend to separate or get as far apart as possible, while the elements of current in different conductors carrying current in opposite directions attract each other. The phenomena of "mutual" as well as "self-induction" and "skin effect" enter the problem. The current distribution in any conductor or set of conductors then depends upon the frequency, size of conductor and the nearness of the return circuit.

In addition, therefore, to determining the shape of the conductors so that they will be used to the best advantage without excessive heating, it is most important to secure proper relative position of positive conductors with respect to negative conductors so that the inductance of the circuit will be a minimum or within desirable limit. The current distribution within a conductor adjacent to a conductor of opposite polarity is affected as above indicated in manner that the current tends to take the surface near to it. This is due to the fact that the mutual inductance is at a maximum on the near surface and, therefore, has a greater effect in reducing the self-inductance. In this way, the net inductance of an area near the inner surface is less than for an equal area near the outer surface.

Furnace transformer low tension leads are generally interlaced alternately positive and negative when brought through the transformer case, as shown in Fig. 2, for a three-phase, shell type transformer for industrial service. In this way the inductance of the leads is kept at minimum because of the subtractive effect of the mutual inductance of adjacent bars of

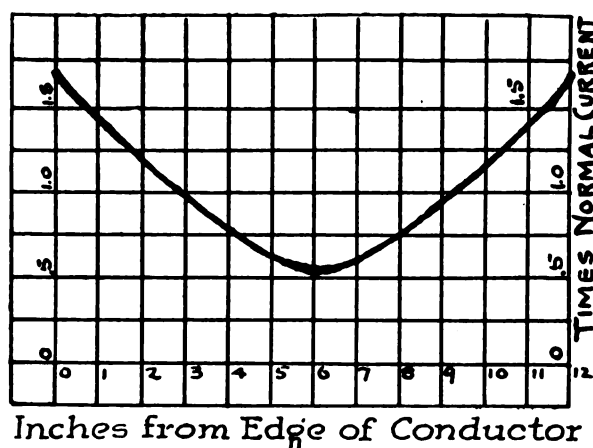


Fig. 1

FIG. 1—Inductance curve.

it has reached such a value that the effective resistance has increased approximately 25 per cent over the corresponding resistance to direct current. With 60 cycles, the one-half-in. cylindrical conductor offers a small increase in resistance to the passage of current; the one-in. conductor offers a 11 per cent increase and the two-in. conductor offers approximately a 75 per cent increase over the resistance to direct current. Different conducting materials have different "skin

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opposite polarity. It is well to use as few bars as possible in parallel per lead. A single bar $\frac{1}{4}$ in. x 12 in. is preferable to two bars $\frac{1}{4}$ in. x 6 in. The bars should not exceed $\frac{5}{16}$ in. thickness at 60 cycles nor $\frac{1}{2}$ in. at 25 cycles. They should not be separated by a distance less than their thickness. Fig. 3 indicates that from 6 in. to 8 in. is a good practical value for "(a)."

Low Tension Bus.

To reduce the reactance and unequal distribution

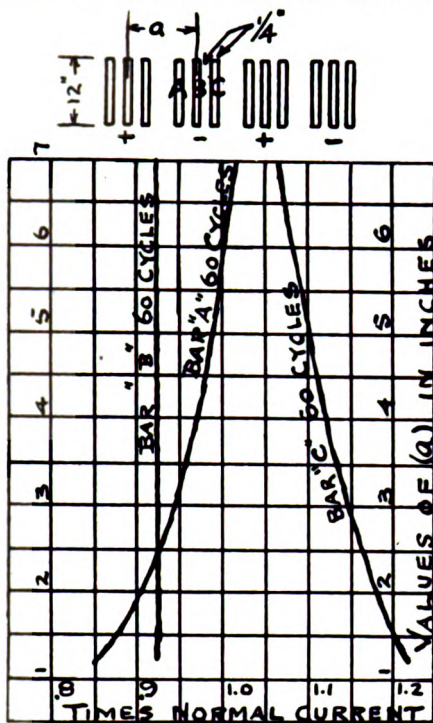


Fig. 2

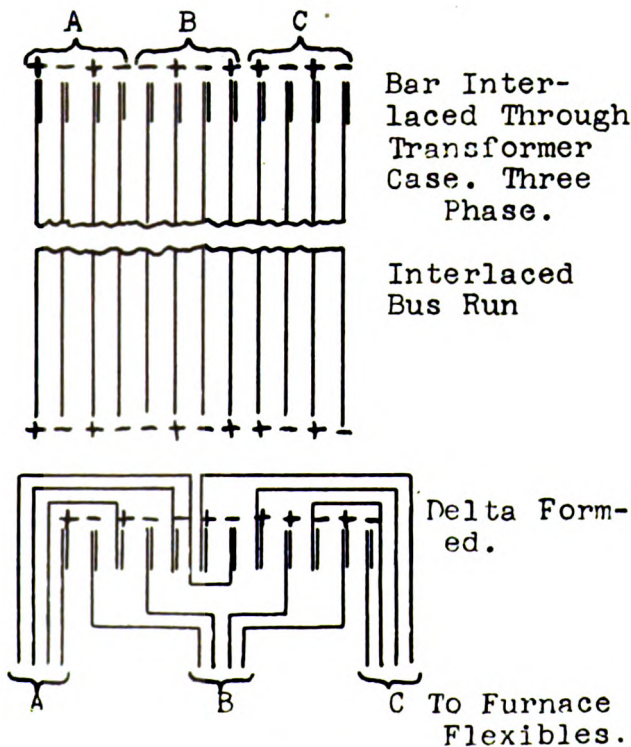


Fig. 3

of current to a minimum, it is best practice in the heaviest current-carrying structures to use an interlaced bus, similar to the transformer leads, in the connection between transformers and furnace up to the point where the flexibles begin. Interphase connections such as delta or star jumpers should be made as near to the furnace as possible in such cases. In this illustration

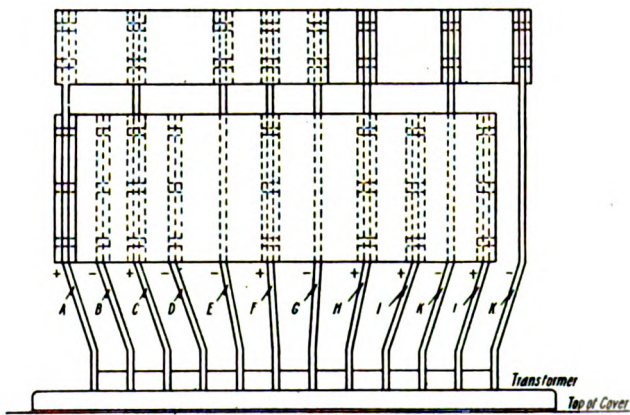
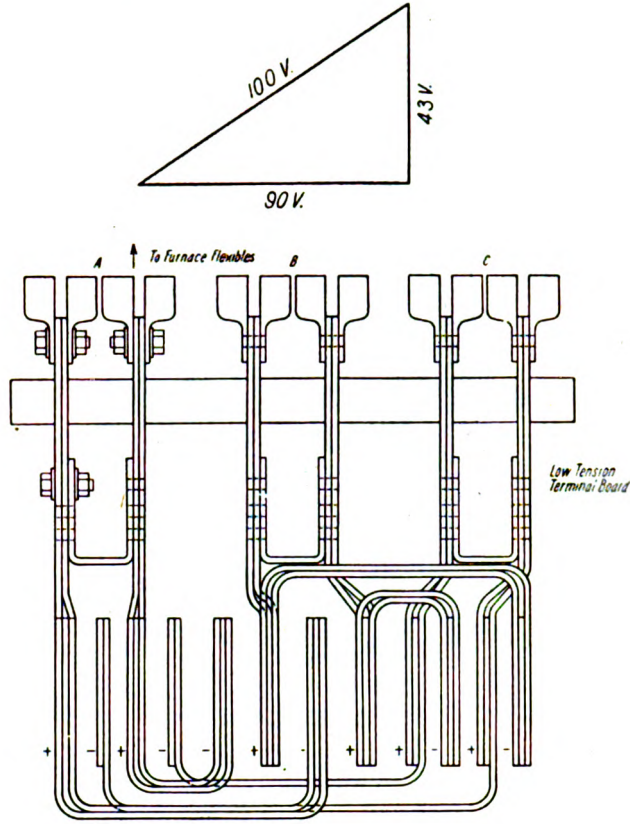


Fig. 4

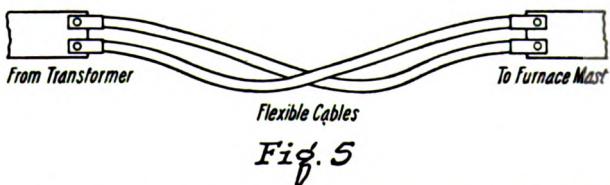


Fig. 5

FIG. 4—Is diagrammatic sketch of the delta connections.
FIG. 5—Flexible cables.

delta connections are made at the point where the interlaced leads end and the flexibles begin. In the case of the 3,000-kw. Ferro-Vanadium furnace shown

on Page 452, the Electrical World, February 24, 1923, the flexibles are interlaced and the delta is formed where they end at the furnace. It is unusual that the transformers can be located so close to the furnace that the leads may consist of flexibles only. Photos that the leads may consist of flexibles only. Figs. 7 and 8 illustrate such a case, however, with the interphase connections made on top of the transformer. The secondary transformer leads are brought through the cover interlaced and the delta is formed above the cover. Terminals are provided for ten two million circular mill cables per phase, which form the flexibles, directly connecting the transformer to the furnace electrode holders.

Three thousand kva. max. rated, three-phase, 60 cycle, delta delta connected, 11,000 volts to 110 volts (also 122, 100 and 92 volt operating voltages by high tension taps) O. I. W. C. Westinghouse furnace trans-

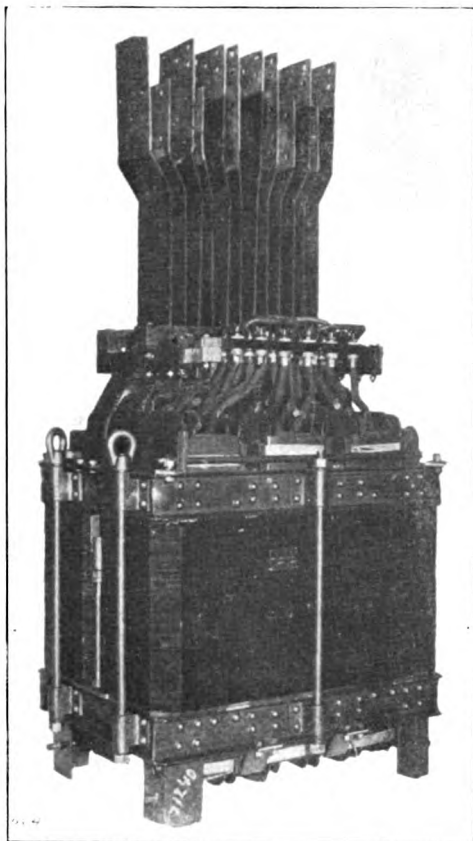


FIG. 6—Shows transformer core and coils out of case.

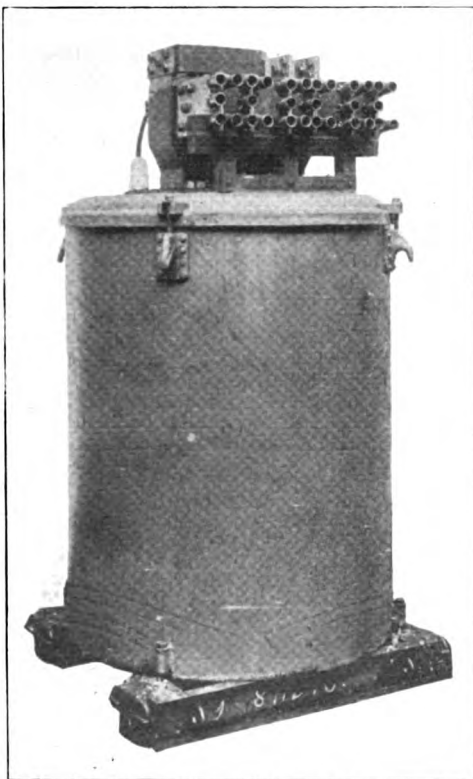


FIG. 7—Shows rear view.

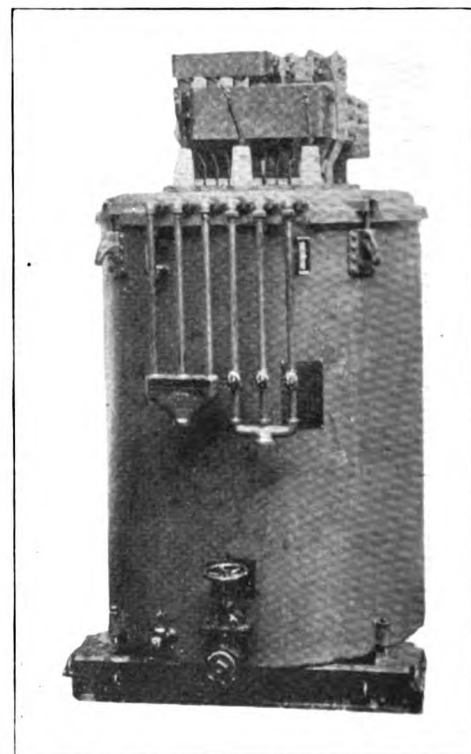


FIG. 8—Shows front view.

former used in connection with a 15-ton Heroult furnace at the National Malleable Casting Company. This transformer has four secondary coils per phase in two parallels, each carrying normally about 1,600 amperes.

In somewhat smaller installations it is practical, where on account of a long run, it is necessary to interlace, to form the star* or delta connections at the transformer and to interlace the three phases from that point. With the usual short lengths of run of low tension bus bars, transposition of the bus bars is not necessary. However, transposition would be desirable, if practicable; for, with three separated phase groups of bars in one run, the two outer groups will have greater inductance than the center group. It is generally not necessary to employ transposition in the flexible cables for currents up to 20,000 amperes, at 60 cycles, and 40,000 amperes or more, at 25 cycles.

(Continued in October.)

The POWER PLANT

What Management Should Know of Coal

An Analytical Summary of the Many Elements Entering into
Power Production Reduced to a Common Basis
for the Busy Executive

By ROBERT JUNE*

THE proper selection of coal, the adoption of the right fuel to the right equipment is a problem, the correct solution of which offers unusual opportunities to effect economies in the operation of the power plant. It is a problem which should ever be taken into consideration in the design of a proposed plant.

Classification of Coals.

The distinctions between the various ranks of coal are not clearly defined. The most satisfactory method for establishing the various classifications is by the

This is the first in a new series of articles by Robert June, the well-known authority on Power Plant Management.† The articles are written from the point of view of the managing executive and deal with the dollars and cents end of Power Plant Operation and Maintenance. Succeeding articles deal with such live topics as Efficient Combustion Practice, Safe and Efficient Boiler Operation, Stoker Operation and Maintenance, What Management Should Know About Coal and Ash Handling Equipment, and so forth. The series is timely and should prove of value to our readers.

use of both Mechanical and Physical Criteria. On this basis the ranks indicated below are arrived at.

Anthracite.

The outstanding characteristic of anthracite is its low volatile content. Because of this it burns with very little flame, giving an intense fire free from smoke. Good anthracite is hard, compact, and lustrous, giving a vitreous fracture when broken. The chemical composition and heat value of anthracite is shown in both Fig. 1 and Table I.

An important source of financial loss in the use of anthracite lies in the fact that no matter how carefully handled, it is liable to break up into very tiny pieces, under the influence of the high temperature of the furnace, when freshly fired, with consequent, large losses of fuel through the grates to the ash pit. As anthracite requires at least 40 per cent greater combustion space than does bituminous coal, it should

never be purchased for use in furnaces not designed for it.

Semi-Anthracite.

This coal reaches the consumer generally under the name of "anthracite," a deception which should not be tolerated. As the name implies, it is inferior to anthracite. It has less fixed carbon and somewhat more volatile. Its characteristics are likewise given in Fig. 1 and Table I.

Super-Bituminous.

This grade of fuel is commonly termed "Semi-Bituminous"—an unfortunate appellation, as it cre-

Lignite	7,400 B.T.U.		
Subbituminous	9,720 B.T.U.		
Low-rank bituminous	12,880 "		
Medium-rank bituminous	13,880 "		
High-rank bituminous	15,160 "		
Low-rank Superbituminous	15,480 "		
High-rank Superbituminous	15,360 "		
Semianthracite	14,880 "		
Anthracite	14,440 "		

Lignite	37.8	18.8	43.4
Subbituminous	42.4	34.2	23.4
Low-rank bituminous	47.0	41.4	11.6
Medium-rank bituminous	54.2	40.8	5.0
High-rank bituminous	64.6	32.2	3.2
Low-rank superbituminous	75.0	22.0	3.0
High-rank superbituminous	83.4	11.6	5.0
Semianthracite	83.8	3.2	10.2
Anthracite	95.6	1.2	

Fig. 1

*Associate Member, A. S. M. E., Detroit, Mich.

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ates the inference that this coal is inferior to bituminous, whereas it is markedly superior.

Another trade name for this fuel is "Smokeless" coal. The latter term is a consequence of the relatively high percentage of fixed carbon which renders the coal practically smokeless when properly burned. The heat value of this fuel is very high and as it requires less bunker and storage space per unit of heat than other coals, it is in great demand for naval and steamship use, as well as for manufacturing plants located in crowded quarters where storage space is at a premium and smoke regulations are enforced.

Super-bituminous coal possesses one characteristic which the public has been prone to regard as a rather serious disadvantage; that is, the coal is quite friable, readily breaking into small pieces not only during the process of mining, but also in transportation and handling. This apparent disadvantage is not necessarily existent, as the coal can be burned with practically no loss through the grates to the ash pit, when fired with mechanical stokers and grates adapted to the fuel. Reference again is made to Fig. 1 and Table I for outstanding characteristics.

Bituminous.

This term is applied to a wide variety of fuels. The classification "bituminous" is based in particular upon the relation of volatile matter in the coal to fixed carbon, but also and more specially to the factor which distinguishes bituminous coals from those of lower rank. This factor is that true bituminous coal is only slightly affected mechanically by weathering even though it be exposed for a long period of years. This is not true of coals of lower rank, which break up readily under the influence of weather.

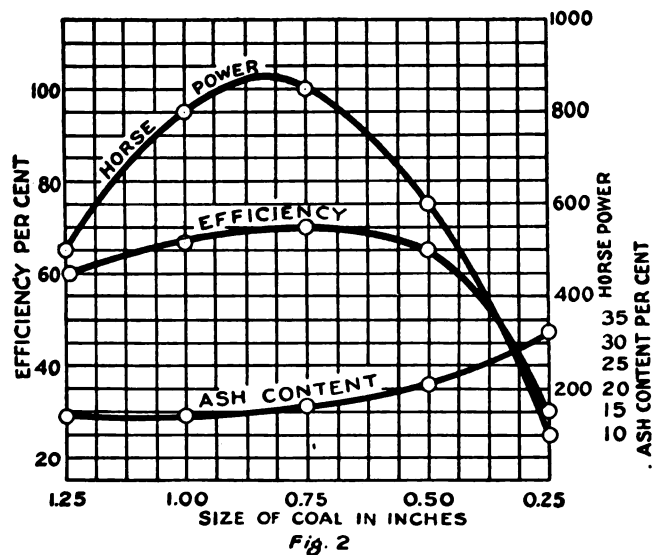


Fig. 2

Many attempts have been made to divide bituminous coals up into characteristic groups. This is not readily accomplished, but the following classifications tell the power plant operator what he ought to know.

(a) Non-coking, dry bituminous coals are the best for steaming purposes. They closely approach super-bituminous in character, being hard and dense, but inclined to be friable, breaking easily in transportation and handling. They ignite readily, and burn freely with short, clean, bluish flame.

(b) Bituminous coking coals, as their name implies, swell up, becoming pasty and fuse together in burning. They have a higher percentage of volatile and less fixed carbon than the free-burning, non-coking coals. Being rich in hydrocarbon, these coals are particularly adapted to gas making. Certain varieties are commonly sold as "Gas Coal."

Long-flaming, bituminous coals are notable smoke producers. Some varieties coke, others do not, so in using coal of this grade for steam purposes care should be taken to secure a supply at all times from the same source; otherwise uncertain combustion conditions will prevail and financial loss ensue. As a general proposition, this coal is preferable for use under dryers, in cement kilns, and so forth, rather than for general steam-making purposes. Where choice may be exercised, the non-coking, free-burning, bituminous coals of the West Virginia, Pittsburg and Illinois districts are to be selected for the production of steam. Again we refer to Fig. 1 and Table I.

Sub-Bituminous.

The distinction between this coal and bituminous lies in the fact that sub-bituminous rapidly loses its moisture and consequently "slacks" to a marked extent when subjected to alternate wetting and drying. As the matters of both size and moisture content are important in buying and shipping coal, there are a number of points to be considered before voluntarily adopting sub-bituminous coal for use in the power plant. For one thing, unless slacking is to be permitted, it is almost necessary to ship sub-bituminous coal in box cars, thus materially increasing the cost of loading and unloading. Another point is that sub-bituminous coal is extremely liable to spontaneous combustion. On the other hand, sub-bituminous is a very clean fuel and ignites with little difficulty.

Lignite.

As used by the Geological Survey, the term "Lignite" is restricted to those coals which are distinctly brown in color and either characteristically "woody" or "clay like" in their appearance. Because of their high moisture content, which may run up to 30 or 40 per cent, these coals cannot be shipped far, as no one wants to pay freight on so much water. Lignites are even more difficult than sub-bituminous coals to handle because of their rapid loss of moisture and marked tendency to slack and to spontaneous combustion. For economical steam generation, Lignite should be purchased near the power plant and practically used as rapidly as received.

Comparison of Different Ranks.

Fig. 1* shows proximate analysis of Btu. value of the various ranks of coal. This diagram is based on the properties of actual samples of commercial fuels in each rank. Fairly regular increase in fixed carbon from lignite to anthracite will be noted. The rapid increase in the moisture in the lower ranks of coal is of interest, as is also the fact that the greatest amount of volatile matter is found in the lower ranks of bituminous.

*Fig. 1 and Table I are based on data presented in "American Fuels" by Marius Campbell of the United States Geological Survey.

TABLE I

Location and Rank of Coal	Moisture	Volatile Matter	Fixed Carbon	Ash	Sulphur	Heat Value Btu.
Alabama						
Lookout Mountain, superbituminous.....	3.8	19.0	64.4	12.8	1.5	12,980
Birmingham District, bituminous coking.....	2.4	25.9	66.8	4.9	1.5	14,490
Arizona						
Russellville District, semi-anthracite.....	2.1	9.8	78.9	9.3	1.7	13,700
Paris District, super-bituminous.....	2.8	14.7	73.4	9.1	2.8	13,770
California						
Stone Canyon District, bituminous.....	7.0	46.7	40.1	6.2	4.2	12,450
Mount Diablo District, sub-bituminous.....	15.0	38.4	34.5	12.1	5.6	9,240
Colorado						
Denver field, sub-bituminous.....	18.8	30.5	44.5	6.2	0.3	9,650
Trinidad field, bituminous, non-coking.....	7.8	38.5	44.8	8.9	0.5	11,540
Newcastle field, bituminous, coking.....	2.9	33.3	56.7	7.1	0.5	13,720
Georgia						
Manlo District, super-bituminous.....	2.9	17.1	72.2	7.8	0.7	14,200
Illinois						
LaSalle County, bituminous.....	13.9	37.3	38.5	10.3	3.4	10,990
Sangamon County, bituminous.....	14.3	37.2	40.3	8.2	4.4	11,010
Gallatin County, bituminous.....	3.4	35.2	52.5	8.9	2.9	13,190
Indiana						
Knox County, bituminous.....	10.6	38.1	43.0	8.3	3.7	11,750
Iowa						
Monroe County, bituminous.....	15.8	36.9	37.9	9.4	4.7	12,900
Kansas						
Crawford County, bituminous.....	4.9	33.5	52.5	9.1	5.0	12,940
Eastern Kentucky						
Bell County, bituminous.....	2.8	37.8	56.3	3.1	1.0	14,240
Western Kentucky						
Union County, bituminous.....	3.9	37.1	49.7	9.3	3.5	12,830
Maryland						
Georges Creek Basin, super-bituminous, high rank.....	0.6	16.0	72.1	10.7	1.3	13,380
Lower Youghiogheny Basin, bituminous.....	2.3	25.5	64.4	7.8	1.1	13,780
Michigan						
Saginaw District, bituminous.....	11.9	31.5	49.8	16.8	1.2	11,780
Missouri						
Barton County, bituminous.....	5.4	32.1	53.6	8.9	3.6	12,990
Montana						
Electric field, bituminous, coking.....	4.0	22.5	59.3	14.2	0.6	12,760
Milloula field, lignite.....	24.7	29.3	26.1	19.9	0.9	6,730
North Dakota						
Adams County, lignite.....	32.4	30.9	28.1	8.6	1.5	7,330
Ohio						
Jefferson County, bituminous.....	4.1	38.5	49.7	7.7	3.7	13,150
Washington County, bituminous.....	3.4	38.7	49.1	9.6	5.0	12,750
Oklahoma						
Haskell County, super-bituminous.....	2.7	21.1	69.9	6.3	0.8	14,100
Oregon						
Eden Ridge field, bituminous.....	12.6	35.0	37.7	14.7	1.3	10,350
Pennsylvania						
Anthracite region, anthracite.....	2.8	1.2	88.2	7.8	0.9	13,300
Sullivan County, semi-bituminous.....	3.4	9.3	75.6	11.7	0.8	13,120
Cambria County, super-bituminous, high rank.....	3.3	12.5	77.9	6.3	1.0	14,340
Westmoreland County, bituminous, coking.....	2.7	30.4	57.8	9.1	1.3	13,610
Allegheny County, bituminous.....	3.7	34.0	56.8	5.5	1.4	13,870
Fayette County, bituminous, coking.....	2.8	30.0	59.8	7.4	1.2	13,990
Tennessee						
Claiborne and Campbell Counties, bituminous.....	3.6	37.3	55.5	3.6	1.1	13,980
Texas						
Houston County, lignite.....	33.5	39.5	16.2	10.8	0.6	7,140
Utah						
Carbon County, bituminous.....	4.4	38.2	50.5	6.9	0.8	12,760
Virginia (Appalachian Region)						
Tazewell County, super-bituminous.....	3.8	15.5	77.8	2.9	0.6	14,860
Russell County, bituminous.....	2.8	34.9	56.5	5.8	0.6	14,150
Washington						
Whatcom County, anthracite.....	4.4	7.4	76.0	12.2	1.0	12,590
Black Diamond District, bituminous.....	6.8	40.0	47.9	5.3	1.4	12,330
West Virginia						
Wheeling District, bituminous.....	4.1	36.6	53.3	6.0	2.1	13,400
Fairmont District, bituminous.....	2.9	34.5	56.9	5.7	0.7	14,040
Upper Potomac Basin, super-bituminous, high rank.....	1.1	17.2	73.8	7.9	1.1	14,490
New River District, semi-bituminous, low rank.....	3.5	22.2	71.9	2.4	0.7	14,690
Montgomery District, bituminous.....	2.4	35.5	56.7	5.4	1.0	14,160
Pocahontas field, super-bituminous, low rank.....	3.4	22.5	68.8	5.3	0.5	14,370

TABLE II
ANALYSIS OF A TYPICAL WEST VIRGINIA COAL

				Heating Value per lb.	Calculated Btu.	Btu. by Calorimeter
Moisture	2.01	{ H 0.22 O 1.79	2.01 water	None	.....	.....
Volatile	37.31	{ H 4.86 O 4.78 C 26.65 N .23 S .79	5.38 water 4.26 available H	None 62,000 14,500 None 4,050	 2,641 3,464 32	.....
Fixed carbon	52.13	{ C 49.18 N 1.20 S 1.75		14,500 None 4,050	7,131 71	.....
Ash	8.55			None	.....	.....
					13,339	13,811

ANALYSIS OF A TYPICAL ILLINOIS COAL

				Heating Value per lb.	Calculated Btu.	Btu. by Calorimeter
Moisture	12.39	{ H 1.38 O 11.01	12.39 water	None	.....	.....
Volatile	36.89	{ H 4.47 O 8.01 C 23.19 N .10 S 1.12	9.01 water 3.47 available H	None 62,000 14,500 None 4,050	 2,150 3,363 46	.....
Fixed Carbon	41.80	{ C 38.10 N .90 S 2.80		14,500 None 4,050	5,525 113	.....
Ash	8.92			None	.....	.....
					11,197	11,399

The diagram at the right shows the Btu. value of the coals on an ash-free basis. It will be seen that the best coal for steaming purposes is low-rank super-bituminous and that lignite possesses very slight value indeed.

Geographical Distribution of Coal.

Representative coals of each section of the United States are shown in Table I, which is a compilation of analyses made by the United States Geological Survey and the Bureau of Mines.

Moisture in Coal.

Not only is moisture a non-combustible but it absorbs heat because it must be vaporized and discharged at stack temperature. Where the moisture percentage is small this is not such a serious matter, as 1 per cent of moisture amounts to only one-tenth of 1 per cent of 13,000 Btu. coal if we assume somewhat high stack temperature of 700 deg.

Another point with respect to moisture is important, the usual chemical analyses of coal do not show all of the moisture. The reason for this is that there is considerable amount of water which cannot be driven out of the coal even at 220 deg. F., but remains in chemical combination usually as a carbo-hydrate, which can only be driven off with volatile.

In a typical West Virginia coal, 13 per cent of the volatile has been found to be water. In a typical Illinois coal 25 per cent of the volatile itself is non-combustible in the form of water. The analyses of these two coals, for which we are indebted to Mr. E. G. Bailey, is given in Table II. This means that in making comparative appraisals of coals from different fields or in purchasing coal under specification the moisture content of the volatile as well as the free moisture should be taken into consideration to secure accurate results.

Ash.

Ash is a complex compound consisting of iron, lime, alumina, magnesia, silica, titanium and various alkalis.

It is to be considered from two points. First, in buying coal with any appreciable percentage of ash in it you are paying not only the first cost but also freight and handling charges all through your plant for so much inert material. The second is of utmost importance. It concerns us with the fusing temperature of the ash and the actual temperature to which the ash is subjected in the furnace. There are coals, the ash of which has such a high fusing temperature that there are practically no fuel bed conditions which will produce troublesome clinker. Next we find a different type of ash with a lower fusing temperature. This ash will clinker, but in doing so it forms a porous spongy mass which does not materially obstruct the flow of air nor prove difficult to remove. The really troublesome ash is that which has a low fusing temperature—say 2,100 deg. F. This forms the worst sort of clinker, and the question of the use of coal which contains it should be given the most careful consideration by the power plant operator.

Influence of Size on Boiler Efficiency..

Bituminous coals are graded and sized as follows:

- (a) Run-of-mine—unscreened coal which has been picked over only for removal of larger pieces of foreign material.
- (b) Lump—coal which will pass over a bar-screen with 1¼-in. openings.
- (c) Nut—coal passing through bar-screen with 1¼-in. openings and over a screen with ¾-in. openings.
- (d) Slack—coal which passes through a bar-screen with ¾-in. openings.

TABLE III

Completeness of Combustion, Per Cent of Undeveloped Heat.	Rate of Combustion, lbs. per sq. ft. of Grate per Hour.	Excess of Air Per Cent	Pocahontas	Pittsburgh	Illinois
5	50	50	2.7	2.9	4.3
3	50	50	3.2	3.7	5.3
2	50	50	3.6	4.4	6.3
1	50	50	4.0	5.6	8.9
0.5	50	50	4.8	6.8	11.9
5	25	50	2.0	2.2	3.5
3	25	50	2.3	2.7	4.35
2	25	50	2.7	3.1	5.1
1	25	50	3.4	4.0	6.2
0.5	25	50	4.0	5.0	7.1

Anthracite coal is graded and sized as follows:

(a) Run-of-mine—unscreened coal from which larger pieces of foreign material only have been picked.

(b) Lump—classified as 6-in., 3-in. and 1¼-in., according as the coal passes through circular openings of the larger diameter and over openings of the smaller diameter.

(c) Nut—classified as follows: Three-in.—smaller than 3-in. and larger than 1¼-in. in diameter. One and quarter-in.—smaller than 1¼-in. and larger than ¾-in. Three quarter-in.—smaller than ¾-in.

(d) Screenings—everything which passes through a 1¼-in. screen.

The size of coal affects the draft of the furnace and influences the capacity of the boiler. Thus, the presence of large quantities of fine coal and dust will materially check the flow of air through the fuel bed. When fine coal is used thin fires are necessary, and this usually results in a decrease in boiler efficiency, due to the presence of holes in the fire.

The percentage of ash in fuel generally increases materially as the size of the coal decreases. The explanation is that dust and small pieces of foreign material from the roof or floor of the mine, having been separated from the larger coal, naturally find their way into the smaller coal. Fig. 2 illustrates the influence of the size of screenings on the capacity and efficiency of a 500-hp. boiler fired by chain grate stokers.

The size of coal best suited to individual plant operating conditions should be determined by a series of tests. Once the most efficient size has been determined it will be found profitable to insist that all deliveries conform to this size.

Combustion Space Required for Various Coals.

Different coals require different combustion spaces—the size of the combustion space required being principally determined by the quantity and quality of the volatile matter, as indicated by the ratio of volatile carbon to available hydrogen, and also by the oxygen content of the coal on a moisture and ash-free basis. As an illustration of the influence of chemical composition of coal on the combustion space required, we include Table II, which shows the space requirements

for three typical coals under various conditions.

Fig. 3 furnishes an illustration of the point that the size of the required combustion space is dependent upon both the quantity and quality of the volatile matter and does not depend upon the percentage of volatile alone.

It is well worth while to have the combustion space in your furnaces checked up against the coal which you are now buying. In putting in new boilers be sure that the combustion space in the furnaces is designed for the coal which you can buy to best advantage.

Btu. Content of Coal.

It is important to know the Btu. content of the coal which you are using. It is common to speak of an evaporation of 8 or 9 or 10 pounds of water per pound of coal as representing a relatively high efficiency. Such figures, however, mean nothing unless

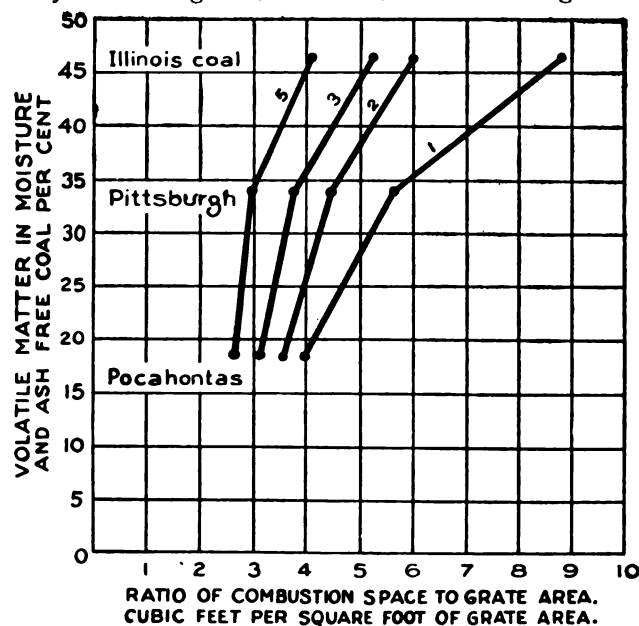


Fig. 3

the Btu. content of the coal is also given. For example, if coal contains 11,000 Btu. per pound, the equivalent evaporation of 8 pounds of water per pound of dry coal would represent 70.5 per cent efficiency. However, if the coal contained 14,500 Btu. the evaporation of 8 pounds of water would represent only 53.5 per cent efficiency.

Points on the Purchase of Coal.

Complete analyses of coal entering your yard should be made at frequent intervals. If you haven't a laboratory of your own put a barre in the boiler room, have the fireman throw in a shovel from different parts of the car to be tested, then mix and quarter the contents of the barrel until you have a representative sample, which you can forward to the nearest testing laboratory. In making a contract for the purchase of coal under specifications, the following points should be taken into consideration:

- (1) Amount and description.
- (2) Time and conditions of delivery.
- (3) Adjustment in price for variations in Btu. content, moisture and ash.

(Continued on page 503.)

The Generation of Steam by Electricity*

By PHILIP H. FALTER†

THE electric steam boiler, or generator, is not exactly new, having been used in various parts of Europe during the last 16 years, but its use on this side of the Atlantic only began, on a commercial scale, somewhat over two years ago. In Europe, even after 16 years, it is only beginning to be used in a really large way, and none of the units now in use even approach in capacity some of the large units now running in this country and in Canada.

The development of the electro-steam generator was brought about in America by a condition resulting after

alive and for a while it led a very precarious existence. The writer was vice president and general manager of said company during that time. Steam was required in winter even when not operating in order to preserve the property. Coal was brought up from Pennsylvania at continually increasing cost. At the same time the business of the power company had fallen off so that it had idle generating machinery and tremendous volumes of water going to waste over Shawinigan Falls.

It finally dawned upon us that we could get our steam for almost literally nothing if it could be generated electrically. The generating capacity and water were available, transmission lines ran to the chemical plant, so that we lacked only the steam generator. We tried to buy one or more. We had difficulty in the first place in getting the small appropriation and then, strange as it may seem, we found the European manufacturers indifferent. They had only small units to offer, loaded up with so-called automatic devices, their prices were enormous, and their deliveries discouraging. It was then decided to design a simple rugged electric boiler free from complicated mechanism, but which would effectively make use of the electricity available, and Mr. F. T. Kaelin, chief engineer of the Shawinigan Water & Power Company, and the writer designed and put into operation the first experimental unit, which, after some alterations, proved very satisfactory.

Passing over development details, there are today in use or under construction in this country and in Canada boilers or water heaters of the Kaelin development aggregating over 200,000 kw. or 20,000 bhp., their operating voltages range from 220 to 22,000 volts, single phase, two phase or three phase. Steam pressures run from 4 lbs. up to 220 lbs. gauge, with capacities up to 35,000 kw. or 3,500 bhp., and water heaters up to 720 gallons per minute, operating under pressures up to 100 lbs. Aside from the boilers built for the Canadian Electro Products Company, Ltd., the first large unit is that in the paper mill of the Belgian Industrial Company at Shawinigan Falls. That unit was started at the end of September, 1921. Thus practically the entire capacity has been installed or undertaken during the past 16 months.

There are three recognized methods of heating water electrically—indirectly, by direct resistance, and the electrode method. The indirect method is most familiar. The heating element is encased in a water tight tube which is immersed in water. In the second, bare wires, ribbons or rods carrying current are immersed in water. Thirdly, the so-called electrode method which might more properly be termed the direct resistance method since the resistance of the water itself causes it to heat as the current flows through it from electrode to electrode, or from the electrodes to the grounded neutral. The elements in the first two types must be at all times immersed to prevent burning out. Both kinds depend also on insulation to prevent short-circuiting and grounding. Their usefulness is therefore limited to equipment of very low capacity.

The electrode or water resistance method, though not a sure cure for all water heating troubles lends itself to such a wide range of usefulness that its development is extremely interesting. The capacity of units may range from the minute to the 35,000 kw. (3,500 bhp.) boilers now in use. Boilers of 50,000 kw. (5,000 bhp.) are now

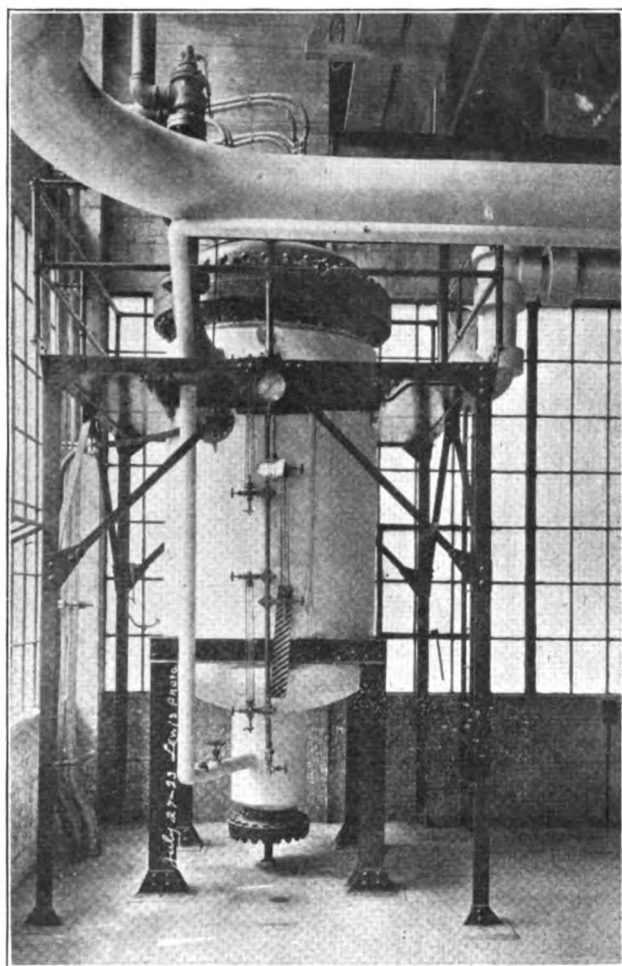


FIG. 1—5,000-kw. electro steam boiler installed at Washington Pulp & Paper Company, Port Angeles, Wash. (V. D. Simons, Chicago, Engineer), by Electric Furnace Construction Company, Philadelphia, operating on 2200-volt., 3-phase, 60-cycle circuit.

the ending of the great war. At Shawinigan Falls, Quebec, the Shawinigan Water & Power Company built during the war a large chemical plant, the business of which was, and still is, conducted in the name of the Canadian Electro Products Company, Limited. After the armistice this company had to find business to keep it

*Presented at Philadelphia Section Meeting, February 3, 1923.

†Vice President, the Electric Furnace Construction Company, Philadelphia, Pa.

under consideration for two large projects. There is no reason why 100,000 kw. (10,000 bhp.) units should not be used. The operation of such a unit is as easy as the operation of a 1,000 kw. (100bhp.) unit. The single attendant per shift could easily look after two or three such units since his principal and almost his only duty is to vary the water level to follow the steam demand.

In its simplest form the water resistance heater is "nothing but a water rheostat. Each is very nearly perfect in efficiency; the latter in wasting energy and the former in turning it to profitable use. It is clear that the energy put into an electric boiler or water heater all goes into the water. The only losses that are possible, therefore, are radiation losses which can be kept quite low by proper heat insulation and a small loss from bleeding or blowing down to get rid of the impurities left behind when the water is evaporated. No inefficiency can result from carelessness on the part of the single attendant or total lack of attendance. Compare this with what may happen in even the best equipped fuel-fired boilers where the highest fuel efficiency known is around 85 per cent, and then with the great number of small hand-fired boilers equipped only with a gauge and a water glass where it is probably in the neighborhood of 30 per cent. The attendant in either of these cases is all-important.

Enthusiasm over the high efficiency of an electric

boiler sometimes leads beyond proper bounds. A very estimable and prosperous Southern gentleman who refused to be convinced that he did not have cheap enough electricity to emancipate him from coal burning, when told that the large electric boiler is from 96 per cent to 98 per cent efficient, thought that some one would find a way to increase it. Reminded that only 2 to 4 per cent remained to be recovered he replied, "Oh, well* some day some smart down-East Yankee will discover how to recover the electricity after it has made steam."

The proper design of an electric boiler or water heater requires very careful attention. First, all boiler code rules and special state regulations must be complied with. There are atmospheric pressure, water service pressures, and low, standard and high steam pressures. In the case of new equipment, the selection of correct operating voltage may have a great bearing on the efficiency of the boiler. The question of current densities is also very important. A boiler that will meet one condition of water may not be suitable for another. Even the frequency employed influences the design.

Boiler feed waters vary greatly in electrical conductivity or specific resistance, and must be as carefully taken into consideration as the chemical qualities where used in fuel-fired boilers. The adding of chemicals to electric boiler feed waters is to be avoided. Even in

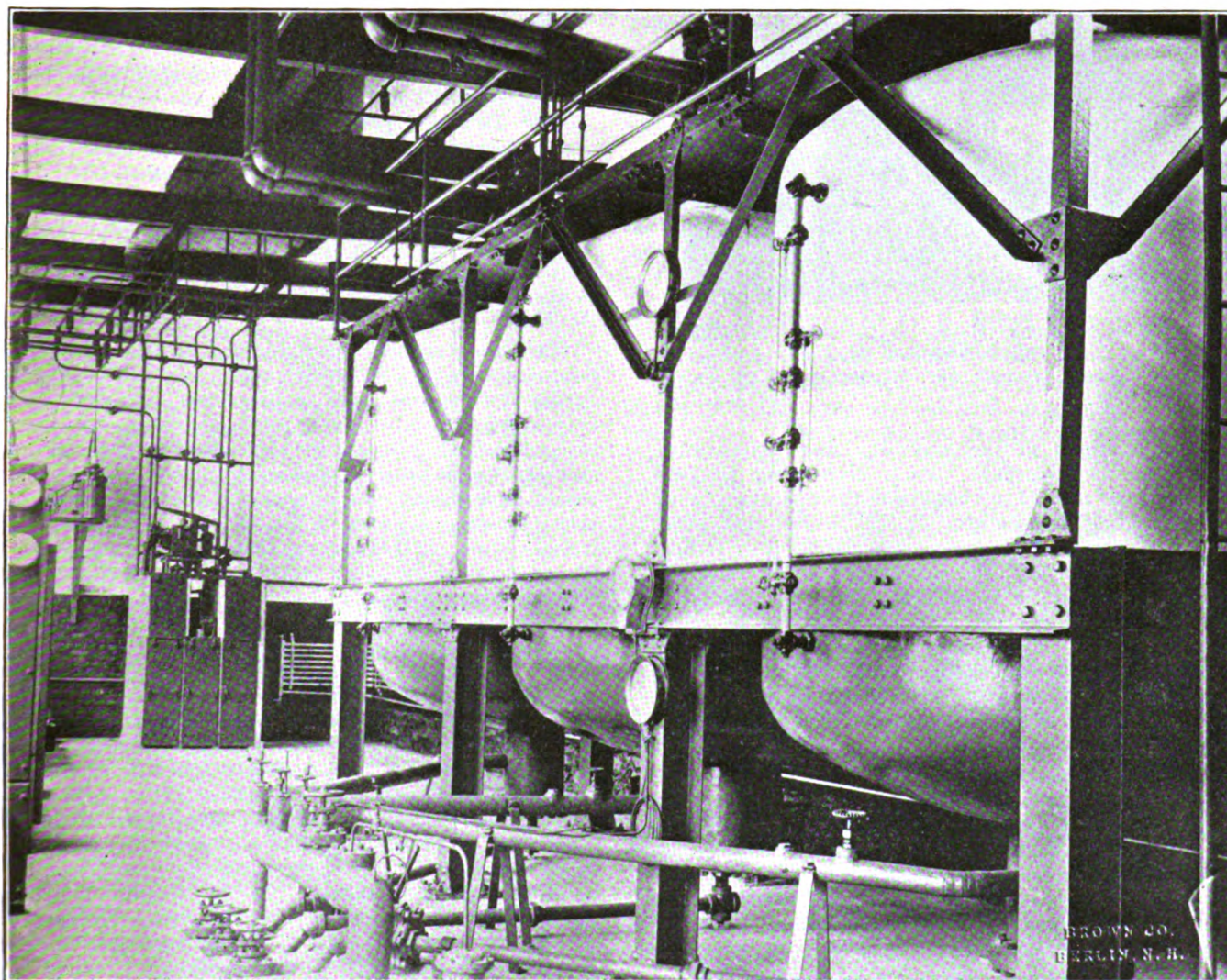


FIG. 2—18,000-kw. electro steam boiler, Kaelin system, installed at the Brown Company, Berlin, N. H., by Electric Furnace Construction Company, Philadelphia, operating directly on 22,000-volts, 3-phase, 60-cycle circuit. Capacity 60 tons of water evaporated to steam at 125 lbs. pressure per hour.

Europe where "doping" the water to change its resistivity was once in general use, the practice is now frowned upon.

One of the most difficult questions to decide in the design of our electric boiler was the question of automatic devices. The fact that the height of water in the tank controls power input and thus the amount of steam generated, renders a boiler so nearly self-automatic that addi-

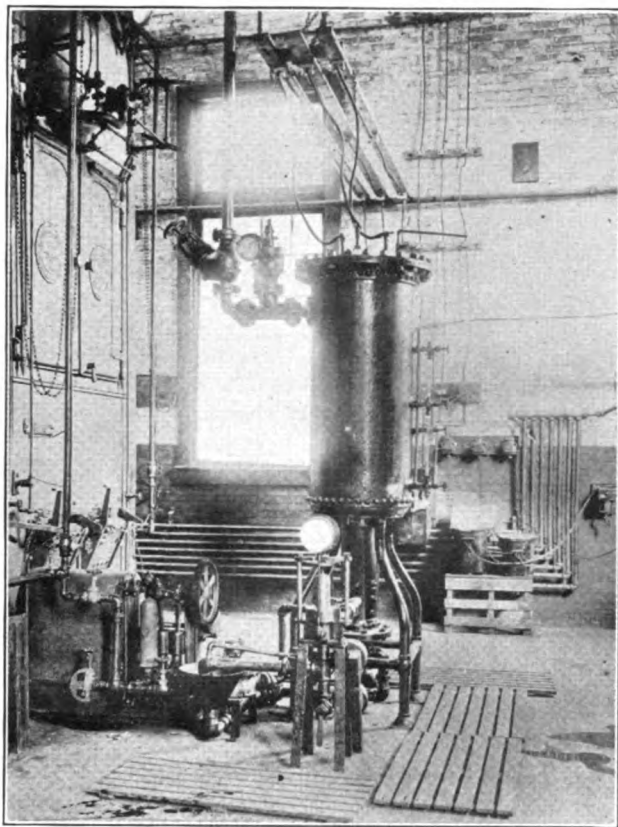


FIG. 3—1,500-kw., 150-bhp. electric steam boiler installed at works of Canadian Electric Products Company, operating on 2200-volt, 3-phase, 60-cycle line. Evaporates 4,500 lbs. of water per hour.

tional complications in the way of inner plates, diaphragm, separate chambers, pump circulating systems etc., were found merely to complicate the operation, with no corresponding advantages. It was found that most of the so-called automatic devices had the habit of failing at the critical time and the accessories often required more attention than the main apparatus. On the large boilers a man is always in attendance on one or more boilers and it is a simple matter for him to keep an eye on the water levels. The automatic devices and interior complications as applied to electric steam boilers are merely new sources of possible trouble and apt to destroy the simplicity of the whole job.

There is little that can go wrong in a properly designed electric boiler. On high voltages insulators give some trouble and electrodes wear must be allowed for. Neither item is serious as affecting the safety of the boiler and repairs can be made quickly and cheaply. In addition to the usual safety valves required by the Boiler Code, automatic circuit breakers, or in small boilers, fuses are employed to cut off the current if it goes too high. The condition of low water, so much feared in other boilers, merely means a lower steam production, and should the water go below the ends of the electrodes no current will flow—the boiler is shut down. The orthodox boiler

fireman positively must be shown before he believes this fact.

In our first boilers at Shawinigan Falls, we employed iron plates bent to the arc of a circle and suspended from the conducting rods within the boilers so as to hang concentric, and thus parallel with the neutral shell which formed a protective lining for the boiler shell proper. This construction, while fair, does not lend itself to adjustments which are sometimes necessary. The round electrode was also employed but is not as satisfactory as the concentric method from the standpoint of definite calculation of current distribution. Both of these methods are for use in the smaller boilers up to 7,500 kw. (750 bhp.), and for voltages up to 2,300 volts.

For higher capacities and particularly for higher voltages, the multiple tank design is generally used. It is equally satisfactory for small boilers, but is somewhat higher in first cost. For three-phase power three tanks are used and two tanks for a two-phase supply. Each tank is a separate single-phase boiler, having one cylindrical electrode suspended in its center by one or more supporting rods or cables which serve to bring in the current. The water supply and bleed for each tank are independently manipulated so as to keep the same amount of power flowing through each and thus to balance the phases on a polyphase system. The steam is piped into a common header.

The designs or types of small boilers or water heaters are too numerous to cover at this time. The designs vary more because of their application to a particular purpose than in the boiler or heater proper.

One kwh. will produce from 2.75 lbs. to 3.3 lbs. of steam, depending upon the pressure and more particularly upon the temperature of the feed water. At 125 lbs. gauge pressure and feed water at 200 deg. F., one kwh. will produce 3.23 lbs. of steam at 97 per cent boiler efficiency. One bhp. being assumed as 30 lbs. of steam per hour, it follows that in round figures 10 kwh. are equivalent to 1 bhp. Thus a 1,000 kw. boiler has a capacity of 100 bhp.

The most natural place for the large electric steam producer is where hydroelectric energy is developed in excess of the more usual requirements, or where coal is very expensive and water power is available. The electric boiler has made possibly the development of certain pulp and paper mill projects in Canada and elsewhere, which would have proved uneconomical if coal had been necessary. Assume a paper mill requiring 5,000 bhp. This would require 47,000 kw. capable of producing 3,600,000 lbs. of steam in 24 hours. Assume that if produced from coal an evaporation of 9 lbs. of steam per pound of coal could be maintained. Then 400,000 lbs. or 178.5 long tons of coal would be required daily. At \$8 per ton under the boilers, this would cost \$1,428 per day or \$428,400 for a year of only 300 days. All these assumptions are in favor of coal burning and consequently the most difficult that the electric boiler would have to meet. Yet, if we capitalize the annual coal bill at 10 per cent for interest and depreciation, it will make possible the expenditure of \$90 per kw. for the hydroelectric plant which would displace coal. The plant would not need stepup or step-down transformers, if the generators are chosen of a voltage to suit the boilers. The transmission line would be very short. Probably much less than \$90 per kw. would be sufficient. At \$75, for instance, it could compete with coal at \$6.67, and at \$60 with coal at \$5.33 per ton.

In New England there are a great many places where streams have been dammed to develop a small amount of

power with which to drive a mill. The rest of the water has gone to waste for generations. Yet all of these mills require a certain amount of steam during the long winters, and some of them have been burning coal the year round for the production of process steam on a small scale, yielding only from three to five pounds evaporation per pound of coal. Assume that 500 electrical hp., or 375 kw., additional could be developed from water available only 200 days per year. Assume an evaporation of 5 lbs per pound of coal and coal at \$10 per long ton. The mill owner could afford to spend \$138.54 per kw. for an additional penstock, power house extension, water wheel and electric and steam generators, the dam being already available, and be thereafter independent of coal. At \$100 per kw. he would be independent even of coal at \$7.20 per long ton.

Some large users purchase power en bloc at a fixed rate per year. Seldom do they approach a 100 per cent load factor. The electric steam generator, by using any surplus during the day or night, Saturday afternoons, Sundays and other holidays, produces a corresponding amount of steam almost literally for nothing if it is located in the boiler house. It quickly pays for itself by the saving in coal displaced.

There are many industries and some institutions in which a small amount of steam or hot water is required at intervals, for which a coal-fired boiler must be kept in service. The greater part of the fuel is consumed while standing by. In such cases prevailing rates for electric power can often be paid and the steam or hot water produced at less cost than with coal. But here demand charges often prove too high. However, overall costs of the two methods of production must be carefully compared.

It is quite feasible to store steam with only slight loss of heat for quite a number of hours. There are plenty of power contracts conferring the right to use power throughout the 24 hours of the day. But peaks and consequently demand charges are established during the working day. Within this peak, power used at night is subject only to the energy charge. It requires large tanks to store a comparatively small amount of steam. Thus to store 15000 pounds which can be produced with 400 kw. used 12 hours, at a pressure of 125 lbs. for use at 5 lbs., a tank 10 feet in diameter and 22 feet long is required. The principal use for steam storage in this country thus far is in fireless steam locomotives as built by the H. K. Porter Company of Pittsburgh. The steam with which they are charged is generally produced with coal. The electric boiler will in all probability be used in connection with steam storage tanks here as in Europe. There huge tanks 18 ft. in diameter and 70 ft. long are used. Such tanks are generally placed outdoors with suitable protection of their heat insulating coverings.

The question is very frequently asked, "Why can't we heat our houses by electricity?" We can. Furthermore, it can be done more simply than by any other means, not excepting oil, which is now so popular. A thermostatically controlled water heater or boiler could take the place of the usual furnace. There would be no storage tanks, no coal bin, no ash cans, no dust, smoke and gases, and practically no attendance. The basement could in truth be kept clean as the rest of the house. From an insurance standpoint it should be an ideal way of heating a house. No wires need be run except to the basement. The danger of fire from "crossed wires" is very remote with modern wiring. There would be no open fire, no combustible gases and no danger of overheating.

It all comes down to a question of cost—not to the first cost of the equipment and wiring for that would be comparatively small—but to the cost of operation. Thus far house heating by means of electricity has not been found practicable except in a few special localities and under unusual conditions.

Reduces Ash Handling Costs

Recent developments in the labor situation have brought home more forcefully the advantages of labor-saving equipment around the power house.

Unskilled labor is becoming more pressing in its demands and more choice in the type of work it performs. Handling ashes is dirty, dusty, back-breaking work. Men stay at it only until they can get something less disagreeable. As a result the power plant crew is constantly shifting and changing.

The installation of labor-saving ash handling equipment not only relieves the plant of the turmoil of changing labor but also eliminates from the payroll the services of one or more men.

Foremost among equipment that has cut the power plant payroll is the American Steam Jet Ash Conveyor, manufactured by the Conveyors Corporation of America, 326 West Madison street, Chicago. Many instances are related to confirm the statement.

Up in Canada is the Canada West Coal Company, Ltd., of Taber, Alberta. A steam jet ash conveyor was installed several years ago with a saving of two men and a team. The daily savings amounted to \$12.38. It is noteworthy to remark also that the savings paid for the equipment within a year's time.

Another mine—the Fayette Mine of Terre Haute, Ind., were able to cut two men from the payroll. In a recent letter to the manufacturer the vice president of the mine stated that the American Steam Jet Ash Conveyor saved the wages of two men—\$12.70.

Coal Holdings of U. S. Steel Corporation and Subsidiaries

The United States Steel Corporation controls approximately 800,000 acres of coal land, according to its annual report. These lands are located in Pennsylvania, West Virginia, Kentucky, Illinois, Indiana, Tennessee and Alabama.

Coal and coke subsidiaries of the corporation control 762,670 acres of coal land, 697,465 being owned and 65,205 acres being leased. Of this coal, 419,286 acres is of coking quality and 343,384 acres is steam coal, 699 acres of the former and 5,651 acres of the latter having been acquired during 1922.

During 1922 the Steel Corporation expended \$5,987,117 at its coal properties, \$1,762,609 being for additional acreage and the balance for development of the properties and improvements.—

(Continued from page 499.)

WHAT THE OPERATOR NEEDS TO KNOW OF COAL

- (4) Method of sampling.
- (5) Designation of laboratory.
- (6) Disposition of acceptable coal.

Proper selection of coal is at the very foundation of efficient power plant management. Time invested in the study of this question will pay rich dividends.

CURRENT TECHNICAL DIGEST

Late Patents — British and Foreign.

Extracting and Refining of Nickel. No. 187,111, British. H. Sefton Jones, London.

A process for making ingots or other masses of pure nickel from impure nickel oxides comprises partially reducing the oxide, lixiviating the partially reduced product with dilute hydrochloric or hydrofluoric acids, drying and consolidating the product by pressure, and finally subjecting the masses to calcination in the presence of reducing and desulphurizing agents such as charcoal and lime.

Treatment of Ores. No. 187,220, British. Smidth & Company, Copenhagen.

Iron ores or other powdered ores are agglomerated by being first heated in a rotary furnace under such conditions that they are slightly oxidized, and thereafter treated in a second apparatus such as an endless band, or a shaft or the like, wherein they are subjected to the passage of air, or air and steam, so as to complete the oxidation and agglomeration.

Coking. No. 187,263, British. F. J. and F. West, Manchester; H. D. Madden and F. Boardman, Cardiff, and West's Gas Improvement Company, Ltd., Manchester.

In the destructive distillation of coal and the like, steam and air are supplied to the retort either simultaneously or alternately for the production of water gas through the center of the work extractor shaft and the barrel of the worm. The gases are led from an injector and pipe through a column supporting the coke extractor worm along channels in the worm shaft to holes from which they enter the base of the coke chamber.

Extracting of Metals. No. 181,375, British. P. C. Rushen, London.

In the reduction of tungsten, molybdenum, chromium, titanium, and like metals from their oxides by a thermo-aluminic process, the oxide and the aluminium are not mixed, but are placed in contact, the aluminium being either in powdered or compact form. The reaction may be carried out in a crucible, or, for making bars of tungsten, titanium, etc., an aluminium tube filled with the oxide may be inserted in a refractory tube serving as a crucible.

Furnaces. No. 187,697, British. F. L. Mazzuccheili, Buenos Aires.

Fire-Bars and Grates.—In fire-bars arranged to form a grate, where the air space between adjacent bars varies inversely as the distance from the source of air inlet, either uniformly or in steps longitudinally of the bars, a section is employed, the upper surface of the bar is flat, whilst the sides are concave, and the lower edge is convex.

Bearings. No. 187,718, British. T. Cooper, Kings Lynn.

A cage for roller bearings comprises a pair of rings connected together by curved or V-shaped strips of uniform thickness, each strip serving to separate two rollers from one another. The strips are welded or brazed in recesses in the rings, which may be divided.

Zinc Tubes. No. 188,067, British. W. L. Woodward, Lakewood, O., U. S. A.

Consists in a method of producing seamless ductile zinc tubes from tubular blanks of crystalline cast or extruded metal by breaking up the crystalline structure by means of mechanical treatment in the cold state. The blank may be fitted on a mandrel and subjected to hammering until the metal is ren-

dered ductile, after which the tube may be drawn by ordinary processes. Or, the blank may be subsequently slightly heated and subjected to lateral pressure from the center outwards by apparatus, wherein a mandrel having a conical face and an enlarged portion, is forced through the blank to compress the metal against the sides of the shell.

Gas Purifiers. No. 188,193, British. R. & J. Dempster, Ltd., and R. W. Broadhead, Manchester.

The cover of a gas purifier is held down by means comprising two members, the one pivoted on the purifier body, and the other pivoted on the former, so that when this is moved inwardly, the latter is pressed on to the cover, and by reason of the points which contact with the cover on each side of the longitudinal axis of the first member, is not readily displaced. A clamping ring may be employed to maintain the two members in juxtaposition.

Furnaces. No. 188,422, British. C. L. Burgess, Stoke-on-Trent.

A fire-bar is provided with a longitudinal groove which may have undercut sides for the reception of fire-clay or other refractory material. A deep layer of this material is provided covering the whole top surface of the bar. Side flutes may be provided in the sides of the bar for the passage of air.

Steam Separators. No. 188,453, British. J. F. Gil and J. N. Chaviara, Liverpool.

The steam flows axially into a trunk-like element comprising a number of co-axial annular elements with intermediate spaces from which it passes radially in thin sheets. A spring coil, preferably tapered, projects horizontally from the inlet of the casing, and is closed at its inner end by a cap which is attached to a stem slidably supported by a bridge-piece. The spring may be close coiled, the entry of the steam causing it to expand sufficiently to provide narrow spaces for the outlet of the steam.

Manufacture of Gas. No. 188,607, British. W. Beswick and N. E. Rambush, Stockton-on-Tees.

In a gas-producer the whole or part of the gases generated is carried to pass through a considerable depth, say, 14 feet, of fresh fuel, which is thereby distilled in stages and at low temperature so that the gases leaving the upper part of the producer have a temperature of between 150 deg. and 300 deg. C., and a calorific value of about 170 Btu., high yields of ammonia and low temperature distillation products being obtained. The temperature of the upper fuel zone may be controlled by removing part of the gases generated in the lower part of the producer prior to their reaching the upper zone. A central gas off-take comprises a bell situated near the top of the upper zone so that the ascending gases are distributed evenly over the cross-sectional area of the descending column of fresh fuel.

Hydraulic Transmission Power. No. 188,944, British. Vickers, Ltd., O. H. D. Vickers and M. K. Ingoldby, Westminster.

An hydraulic transmission gear, which may be used to operate the rudder or control surface of aircraft, comprises a variable delivery pump supplying a cylinder, the piston of which is normally held in its central position by a spring, means being provided to permit leakage from one side of the piston to the other through a restricted aperture, the choking effect of which varies according to the position of the piston, so that the length of stroke of the piston varies with the pump delivery.

—Bulletin of Cleveland Scientific & Tech. Institute.

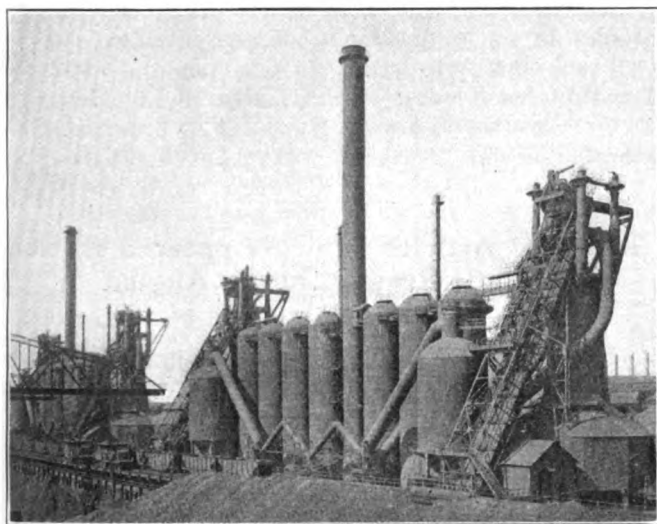
Blast Furnaces at Gary Works Pass 18,000,000 Mark.

On May 11th at 6:40 A. M. blast furnace No. 10 cast the eighteen millionth ton of iron produced by the Gary Works furnaces since the first one, No. 12, was blown in on December 21, 1908. Eighteen million tons is an enormous amount of iron. Written as pounds it would be, 36,000,000,000. To conceive of such an amount of iron is practically impossible, but it might be of interest to try to juggle these figures.

If all this iron were taken in hot metal cars of the capacity used at Gary, or 40 tons, it would require 450,000 cars, which coupled together would form a line 1,800 miles long. In other words, it would form a train extending from New York to Chicago and from Chicago to New Orleans.

If this amount of iron had been cast into a solid pyramid having an area of one square acre at the base the pyramid would be over 600 feet high.

Had the 18,000,000 tons of iron been cast in moulds at our pig casting machines, there would have been over



Blast furnaces at Gary, Indiana.

400,000,000 pigs. If these pigs had been laid side by side and piled on top of each other in layers, it would have been possible to cover every square foot of ground occupied by Gary Works (nearly two square miles) with a pile four feet high and still have enough left over to fill both the machine shop and the foundry to the roof.

If the pigs had, in the same manner, been laid on Broadway covering the space between the curbs from the Baltimore & Ohio highline on the north to the city limits on the south, the pile would have made a gigantic wall 106 feet high.

Strung out in length, end to end, the pigs would have formed a line 152,700 miles long stretching six times around the equator. Or they could have been built into a solid breastwork 3 ft. x 4 in. high all around the United States.

For the benefit of our automobile enthusiasts we might add that all this iron could have been cast into a roadbed 16 ft. wide and 3 in. thick extending from New York to Chicago to Denver to San Francisco to Seattle. This road would have been over a mile longer in the summer than in the winter due to expansion.

Some iron!—Gary Works Circle

What About Henry Ford?

Because of both political and industrial reasons, Henry Ford and the Ford industries are without doubt the most important single topic of discussion within the United States.

To analyze Mr. Ford personally would leave us in possession of only a few uninteresting and average points of ability. Without doubt he has developed the policies of mass production to unheard of heights, but from point of achievement, either educational or through the improvement of any particular science, we find nothing outstanding. Therefore, we must analyze Henry Ford as an industry, for it is there that he has succeeded.

The Ford organization without any contradiction has built and sold more automobiles than it was ever thought possible by even the most progressive engineers, and it is to the credit of Henry Ford that his foresight was correct in judging the ability of the American public to consume the quantity he has produced.

The question is, has the Ford organization ability of an extraordinary nature that would allow them to in quick succession enter the fields of cement, glass, pig iron, raw steel, fabric manufacture, and succeed better than anyone else?

The majority of diversified interests which have been accumulated by the Ford organization either through purchase or development, are the result of two generally known reasons:

(1) The impossibility of the Ford Company to purchase sufficient material at their figures of cost.

(2) The necessity of entering certain fields of manufacture because of the refusal of certain interests to come within the policies dictated by the Ford Company, and while the Ford Company are generally given credit for being able to produce the particular item that may be under consideration and which they have decided to produce themselves at a cost lower than organizations who have been years in building up both the science and the methods, there has never been published, to the knowledge of the writer, any authentic data which would bear out this contention.

Within the last two or three months there have been published innumerable articles on the plant at the River Rouge, some of them indicating that the process and general arrangements were superior to those created by the Steel Corporation, Bethlehem Steel Company, etc.

Because of the mammoth nature of the Rouge plant, that is, as it pertains to the rapidity of its growth, the writer finds that the public majority have accepted its operation as a magnificent success. While it is not the wish to discredit either the River Rouge plant or the product that it produces, we cannot but feel that its true position, as looked upon from the general industrial standpoint, should be one of uniqueness and not one which should be looked upon as a "goal" to be sought after by every organization, for anyone who has had the opportunity to actually inspect this unit there must come the very apparent knowledge that from the miscellaneous nature of its combination, were it to stand alone in the competitive field of the single product of iron and steel production, it would fail to meet competition.—The Ryan Industrial Heat Review.

FEDERAL COAL COMMISSION'S REPORT ON ANTHRACITE

It is found that all the factors involved in mining costs contribute to the increase in mine prices. In the

10 years under review, labor costs in the production of fresh-mined coal have risen from \$1.56 a gross ton in 1913 to \$4.12 in the first quarter of 1923; the cost of supplies from 35 to 71 c., and general expenses from 32 to 92 c. Labor cost bears about the same relation to total mine cost in 1923 as in 1913 (70%); supplies cost total mine cost in 1923 as in 1913 (70 per cent); supplies cost relatively less and general expenses are relatively higher in 1923.

Deficiency of Production.

For 20 years before 1913 production followed closely the increase in population, but since then it has not kept pace with the population either in the nation or in the states which rely upon anthracite as household fuel. From 1913 to 1922 the total production of anthracite remained practically constant except for the extremes of the record year 1917, when it rose to 99,611,811 tons, and the suspension year 1922, when it fell to 54,683,022 tons, while the population is estimated to have increased in the same period about 15 per cent. This steadiness of output is in marked contrast with the extreme fluctuations in the bituminous industry.

Causes of Shortage.

The failure of the anthracite industry to furnish an abundant supply of the domestic sizes is generally not due to a lack of transportation facilities; complaint of car shortage is rare. Failure to visualize the magnitude of the traffic involved in taking the daily output of anthracite to market leads to misapprehension. For several months past, from 6,000 to 7,000 cars have been loaded each working day at the anthracite breakers, so that 45 to 50 miles of cars start on their journeys each day. In its recent decision on the distribution of coal cars, the Interstate Commerce Commission specifically mentions the absence of any reason for continuing the investigation of carriers serving solely anthracite mines. Such community of interest as may exist between the mining of anthracite and its transportation has the beneficial effect of co-ordinating car supply and colliery output.

With one exception, the periods of shortage in the supply of anthracite have been associated with suspensions or strikes at the mines.

Even with a potential monopoly of production, it is not necessary that there should be a combination in restraint of trade, in the legal sense, to explain present price levels.

Only 6 per cent of the coal left the mines during the past winter at prices of \$10 to \$12, as against 77 per cent at the circular prices of \$8 to \$8.50. The influence of this relatively small tonnage of extremely high-priced coal on retail prices was, however, all out of proportion to its amount.

Whether to increase the capacity of the anthracite mines or to make better use of present equipment is an economic as well as an engineering problem. It is estimated there remains a little less than 15,000,000,000 tons in these Pennsylvania fields. The capacity to mine the anthracite is dependent on underground development, the equipment of mines and breakers, and the available labor supply. Of these two factors the lack of labor is the more serious in that, without an adequate labor supply mine development cannot be expanded. The number of employes in the production of anthracite reached its maximum of nearly 180,000 in 1914.

More unskilled miners as well as laborers will be needed to maintain production, to say nothing of increas-

ing it, for there are factors at work tending to lower the production per man.

General Electric Review for August contains the following articles:

	Page
Frontispiece: Turbine-generator Equipped with Surface Air Cooler	526
Editorial: Nature's Laws	527
The Electrons in Chemistry. Part I—By Sir Joseph John Thomson	528
Radio Broadcast Central—By I. F. Byrnes and H. R. Butler	541
Cooling of Turbine Generators. Part IV—By A. R. Smith	554
The Development of Current Limiting Reactors and Their Shunting Resistors—By F. H. Kierstead ..	560
Edison Mazda Lamps in ighthouse Service—By L. C. Porter.....	565
Cargo Winches for Merchant Ships—By C. H. Giroux	570
Studies in the Projection of Light. Part V—By Frank Benford	575
The Probable Number of Stops Made by an Elevator—By Bassett Jones	583
Library Section	588

Principal Articles Which Appeared in Iron Trade Review During August

August 2

More confidence is shown in the iron and steel markets, and the broadened buying of the previous week has been sustained. The prospects for higher mill costs resulting from the elimination of the 12-hour day is tending to stabilize prices. Steel tonnages booked at Chicago are the best in six months. Iron Trade Review's composite of 14 leading iron and steel products shows a slight decline from \$45.09 to \$44.97, due to the easiness in pig iron. An increase in pig iron buying is noted in practically all directions.

In the foreign steel market, Argentina is figuring on 40,000 tons of rails. The De Wendell plant at Lorain has taken 15,000 tons of rails for delivery to England. Japan has placed an order for 10,000 tons of rails with the United States Steel Corporation.

A special editorial by John A. Penton, president of the Penton Publishing Company, publishers of the Iron Trade Review, is printed in this issue, advocating a greater amount of intelligent publicity for the iron and steel industry, as a means of offsetting some of the unjustified attacks lately appearing in various quarters.

The first of the series of articles on the historical features of forging, written by Frank Somers, joint managing director of Walter Somers, Ltd., manufacturer of heavy forgings, Halesowen, England, is presented in this issue.

A comprehensive description is given of the new ore dock of the Great Northern Railway, Allouez, Wis. This dock is nearly a half-mile long and has a storage capacity for 122,150 tons of ore.

An article giving complete data on strip mill production and localities, written by John D. Knox, associate technical editor, at Pittsburgh, of Iron Trade Review, is a feature of this issue.

August 9

A gain in new orders again is registered. The average 14 leading iron and steel products this week is \$44.88 against \$44.97 the week preceding. Pig iron production, due to the one day longer period actually worked, was greater than June, or 3,684,631 tons compared with 3,667,868 tons, and was the largest of any single month on record excepting May, with 3,868,486 tons. During June 26 furnaces were blown out and banked, and three went in, a net loss of 23.

An Eastern Pennsylvania pipe foundry purchased 6,000 tons of foundry pig iron at \$22.85, shipping point, or about \$26.00 delivered. A British producer has taken 19,000 boxes of tin plate for the Nippon Oil Company.

Announcement is made by the board of awards of the American Foundrymen's Association that Enrique Touceda and John Howe Hall have been chosen as the first recipients of the John A. Penton and J. H. Whiting gold medals, respectively.

The widespread use of electric welding in metal working industries is described by P. P. Pipes, a welding engineer, in the New York office of the Lincoln Electric Company, Cleveland, giving some practical applications and records of results.

The adoption of a new soaking pit design at the new plant of the Wisconsin Steel Works, South Chicago, Ill., is described in this issue. Gas and air are reversed by 6-way reversing valves, which are operated simultaneously by control mechanism.

Progress is being made at the new plants for the elimination of the 12-hour day, and it is announced that employees transferred to eight-hour day will receive a 25 per cent increase in the hourly rate.

August 16

The first influences of the practical elimination of the 12-hour day is being talked in the steel market in the firming up of prices. Meanwhile the volume of buying is holding up well, among the week's business is an order for 50,000 tons of rails placed for 1924 delivery.

Production of steel ingots in July was 3,515,965 tons, or at a rate greater than 42,000,000 tons annually, only a little below the best record of any previous year. The composite of 14 iron and steel products this week is practically the same as the week preceding, or \$44.84. Pig iron selling still is in very restricted volume, and prices are weak, as low as \$24.50, valley, but orders were placed for 4,000 to 5,000 tons of foundry and malleable iron.

This issue contains a comprehensive article on the results of the occupation of the Ruhr district by France, written by H. Cole Estep, European manager of Iron Trade Review.

The layout of the new electric steel foundry of the Blackwood Electric Steel Corporation, Parkersburg, W. Va., as described by John D. Knox, permits the rapid progression of work to various stages of production. Steel castings are annealed continuously. The article gives a complete description of the installation.

Plans for the International Foundrymen's Congress and Exhibition in Paris, September 12-16, are progressing rapidly, a list of American and British exchange papers being given in this issue.

The use of monolithic linings for hot blast stoves is described. In the article by George M. Verity, president of the American Rolling Mill Company, it is stated that the steel industry needs: General co-ordination of what has been accomplished by individual companies in human engineering; better appreciation of the industry's respon-

sibilities toward the public and the establishment of department of public psychology and publicity of the American Iron and Steel Institute to keep the public fully informed of the conditions and problems of the industry.

August 23

The volume of new inquiry for pig iron in the iron and steel production is well maintained. The bookings of mills for 1924 have been substantially increased, the estimate of the tonnage for that delivery now being 3,500,000 tons. A Pennsylvania purchaser has taken 2,000 tons of basic Bessemer billets for delivery from Luxemburg at a price equivalent to the price of \$48.50 f. o. b., Antwerp. The price situation in the American market is indicated by the fact that 14 leading iron and steel products this week are \$44.84, the same as the week preceding.

The business sentiment is shown to be improved by the business trend section of Iron Trade Review, and prospects are found to be brightened, by increased trade activity, in the future. Four pages of charts illustrating the business of various trade factors is a feature of all issues of Iron and Trade Review.

The part steel is playing in new highway construction is described at some length in this issue by Frank G. Steinebach, editorial representative of Iron Trade Review.

European industrial managers' experience with the eight-hour day has not been satisfactory judging from the results of the survey made by the European manager of Iron Trade Review, although there is no tendency to revert to the 12-hour shifts. This article, which goes quite extensively into detail, is particularly timely in interest in view of the efforts being made to eliminate the 12-hour day in the American industry.

Contents of Stahl und Eisen During May

May 3—

The Condition of the German Development of the Lorraine and Luxemburg Iron and Steel Industry Up to 1918—Dr.-Ing. Andreas Nerreter in Coblenz 585

Blast Furnace Charging—Dipl.-Ing. T. An. Tesch, Stockholm 590

May 10—

The Rerolling of Old Railway Rails—General Superintendent A. Noll in Duisberg 617

The Condition of the German Development of the Lorraine and Luxemburg iron and steel industry up to 1918 625
(Continued from page 590)

May 17—

The Manner of Working in the Open-Hearth Department of the Hoesch Iron and Steel Plant With Especial Reference to the Hoesch Process and the Heating of the Furnace With Coke-Oven Gas—Dipl.-Ing. Otto Schweitzer, Dortmund 649

The Condition of the German Development of the Lorraine and Luxemburg Iron Industry up to 1918—Dr.-Ing. Andreas Nerreter in Coblenz... 659

May 24—

Changes in the Composition of the Waste Gases Due to Blowing-in and Blowing-out the Blast Furnace as Well as to Changing Different Fluxes. Dr.-Ing. Paul Geimer, Troisdorf 681



Walter A. Barrows, Jr., for many years a well known figure in the pig iron industry, has been appointed blast furnace superintendent for the Robeson Iron Company, Ltd., Robeson, Pa. Mr. Barrows graduated in 1888 from Rutgers College and started his career as chemist at the Sharpsburg, Pa., furnace. He subsequently was chemist for a number of furnaces in the Mahoning Valley Iron Company at Youngstown, which now is the property of the Republic Iron & Steel Company. In 1899 he was appointed superintendent of the blast furnaces of the Shenango Furnace Company. After a short time he went to the Everett furnace of Joseph E. Thropp, as superintendent, but in 1901 returned to the Shenango Furnace Company as manager. In 1907 he engaged in examination of ore properties in Minnesota spending considerable of his time as consulting engineer for the Northern Pacific Railway in connection with its ore developments. In 1916 he became president and general manager of the Thomas Iron Company at Hokendauqua, Pa., continuing in that capacity until the recent sale of that company to the Reading Iron Company.

Dr. Percy Longmuir has resigned as director of research of the British Cast Iron Research Association on account of a breakdown in health. Dr. Longmuir will not formally give up his office until Nov. 1, at which time his successor will be appointed. In the meantime a bulletin detailing the research work he has carried out for the association will be published.

B. M. Stubblefield has been named superintendent of the coke works at the East Youngstown plant of the Youngstown Sheet & Tube Company. Other recent

appointments by Frank C. Farrell, works superintendent of the company include: J. F. Regan as assistant superintendent at the East Youngstown coke plant; G. C. Williams, superintendent at the Brier Hill coke works, and F. D. Schreiber, assistant to Mr. Williams. The appointments are promotions to fill vacancies caused or reaffirmation of positions held under the former management.

Perry C. Mark, for 10 years general superintendent of the Zanesville plant of the Steel & Tube Company of America, which recently was acquired by the Youngstown Sheet & Tube Company, Youngstown, O., has severed his connection with the latter organization. It is understood he will take a much needed vacation and next spring will head an engineering and construction company to be formed at Los Angeles.

H. E. Lewis, vice president of the Bethlehem Steel Company, Bethlehem, Pa., has been appointed a member of the Washington crossing commission board by Gov. Pinchot of Pennsylvania.

H. L. Luech has joined the structural sales organization of the Bethlehem Steel Company at San Francisco. He is a graduate of the University of Wisconsin and before going west took the student training course given by the Bethlehem Steel Company at its plant.

Walter H. Underwood, formerly sales manager of the St. Louis Coke & Iron Company, St. Louis, has been promoted to general manager of sales, with jurisdiction over the entire sales organization of the company. J. C. Gore has been placed in charge of the Chicago territory as general sales agent.

Frank C. Farrell has been named works'

superintendent and Emil F. Vogel, assistant works' superintendent of the East Youngstown plants of the Youngstown Sheet & Tube Company. Mr. Farrell formerly was assistant superintendent of blast furnaces and the steel department while Mr. Vogel was superintendent of the by-product coke ovens.

Edmund S. Gardner, formerly with the American Manganese Steel Company, at its plant in Oakland, Cal., and in Chicago, and subsequently in charge of the installation of electric furnaces for the Best Steel Casting Company, San Francisco, now is in charge of a foundry for the Atlantic, Gulf & Pacific Company, Manila, P. I. Previous to 1920 Mr. Gardner was superintendent of electric furnaces at the South Works of the Illinois Steel Company, Chicago.

Mr. H. R. Stuyvesant, who, for the past four years has been connected with the Alabama Company in the capacity as general superintendent of blast furnaces, has resigned effective October 1st. The company deeply regrets Mr. Stuyvesant's resignation and expresses their high appreciation of the many valued improvements and record breaking practice during his connection with the company. After January 1 Mr. Stuyvesant will again enter the blast furnace business in a much larger and broader capacity.

George F. Murphy, having completed reorganization of the New York office of the Heine Boiler Company, St. Louis, has taken charge of the Philadelphia territory with headquarters in the Pennsylvania building. Harold P. Childs, formerly special representative of the executive offices of the General Electric Company, New

(Continued on page 511.)

TRADE PUBLICATIONS

The Furnace Engineering Company of New York City have recently issued a folder describing and illustrating their new Simplex Unit Pulverizer. Dr. Paul A. Hirsch has associated himself with the company, and production of these pulverizers will be in various sizes ranging in capacities from 750 lbs. to 10,000 lbs. of coal per hour. A number of unique features are claimed for this new type of impact pulverizer.

Large and small owners of electrically driven passenger vehicles, trucks, and tractors will find of special interest bulletin No. 43976 issued by the General Electric Company. This bulletin describes charging equipments for vehicle motive-power batteries which have proved very reliable and satisfactory in service. The manufacturers can furnish equipment for charging motive-power batteries by either the modified constant potential method or the constant current method.

There are two classes of apparatus described in the bulletin.

1. Individual battery charging motor-generator sets with switchboards for Edison or lead batteries: for (a) non-automatic; or (b) automatic operation.

2. Motor-generator sets with switchboards for charging two or more Edison or lead batteries: for (a) non-automatic; or (b) automatic operation.

Due to the varied nature of the sizes of the batteries to be charged, of the requirements to be met with in different localities, of the methods of charging, etc., no attempt has been made in this bulletin to show any but a small proportion of the equipment that this company is prepared to furnish.

NEW CO₂ RECORDER BULLETIN

Bulletin No. 117 of the Uehling Instrument Company, Paterson, N. J., illustrates, in diagrammatic form, the simple principle of operation of Uehling CO₂ recording and indicating equipment.

This fuel economy equipment is unlike all other CO₂ recorders in that it is not a "mechanical Orsat" for it has no moving parts and employs no chemicals in liquid form. Instead, it operates on a simple scientific principle based on varying gas tension between two orifices. Of rugged construction, the equipment is designed to meet all power plant conditions.

The diagram shows the essential parts of the equipment arranged as a train and includes the exclusive features employed in obtaining a clean, dry and desulphurized sample of gas, which is of such paramount importance in flue gas analysis.

BOOK REVIEW

TRINKS ANNOUNCES A RECENT REVIEW

Prof. Tafel's book on roll pass design, has recently appeared in a combined second and third, and enlarged edition. The book is very similar to the first edition which appeared about two years ago, but it contains some new matter particularly concerning the nature of the rolling process and of lateral spreading of steel in the rolls. It takes up design of guides for repeating, and the calculation of the sizes of loops formed in repeating. A great deal of attention is also paid to the rolling of wire rods. Furthermore the book contains many additions, in minor details, throughout the text. The new edition is far ahead of any other existing books on roll pass design.

Prof. Tafel, who, by the way, is professor of Mechanical Engineering of Steel Works at the University of Breslau, Germany, has made an honest attempt to give correct theories and, while we may not agree with everything that he says in the book, yet it surely cannot help but be of great value to those who understand technical German. The book is not a collection of roll passes but like the first addition is an exposition of the underlying principles with many examples. The book is kept in stock by G. E. Stechert & Company, 151 West 25th Street, New York City.

TRADE NOTES

The New Castle Works of the Carnegie Steel Company, New Castle, Pa., have purchased from the Andrews-Bradshaw Company five Tracy Steam Purifiers for their five new 1,530 horse-power Sterling boilers.

The California Cyanide Company has just purchased 16 Uehling CO₂ indicating units for their new plant at Huntington Park, California. The General Chemical Company has purchased three Uehling CO₂ recorders for their East St. Louis plant; they have three units at their Cleveland plant, two at their Edgewater, N. J., plant, and eight units at their Marcus Hook, Pa., plant. The Johns-Mansville Company, who have Uehling equipment at their Manville, N. J., plant, have also just ordered a five-unit equipment for their new plant at Waukegan, Ill. Uehling Instrument Company reports considerable demand for their equipment from other chemical companies including, Atlantic Tar & Chemical Company, Chemical Company of America, Butterworth Judson Company and Vulcan Detinning Company.

The C. & G. Cooper Company of Mt. Vernon, Ohio, announce the discontinuance of both their New York and Pittsburgh offices.

Mr. C. F. Freeman of the Surface Combustion Company, has been transferred from the position of manager of the Pittsburgh District to that of chief engineer. His address is now 366 Gerard Avenue, New York City.

The Fuller Engineering Company will act as sole licensees in the United States and Canada for all new business of the Quigley Fuel Systems, Inc. The engineering personnel of the Quigley Fuel Systems, Inc., has become associated with the Fuller Engineering Company and are now in a better position to render more complete engineering services, as by this arrangement designs can be presented from a wider selection of pulverized fuel equipment.

In the future all business of the Quigley Fuel Systems, Inc., will be conducted through the main and branch offices of the Fuller Engineering Company.

The Kentucky & West Virginia Power Company, Logan, W. Va., has purchased two 15 hp. constant speed Westinghouse a.c. motors to operate clinker grinders. It is interesting to note the recent tendency of large and small power plants to install electrical auxiliaries.

COMING MEETINGS

September 10-14 — American Chemical Society. Fall meeting, Milwaukee. L. Parsons, P. O. Box 1515, Washington, is secretary.

September 17 — American Ceramic Society. Fall meeting, Grand Central Palace, New York. R. C. Purdy, Ohio State University, Columbus, O., is secretary.

September 17-22 — Chemical Industries. National exposition, Grand Central Palace, New York.

September 24-28 — American Association of Iron and Steel Electrical Engineers. Convention and exhibition, Auditorium, Buffalo. Headquarters of the association are located at 1007 Empire Building, Pittsburgh. A program of the papers appears on our preceding pages.

September 27-29 — American Electrochemical Society. Annual meeting at Dayton, O. Dr. Colin G. Fink, Columbia University, New York, is secretary. Papers to be delivered: "Electric Furnace Brass Foundry Practice," H. W. Gillett, chairman. "The Development and Future of Electrodeposition," S. Skowronski, chairman. "Utilization of Chlorine," A. H. Hooker, chairman.

October 8-12 — American Society for Steel Treating. Annual convention at Pittsburgh, W. H. Eisenman, 4600 Prospect Avenue, Cleveland, is secretary.

WITH THE EQUIPMENT MANUFACTURERS

Type ZK Manual Automatic Compensator

Another step has been taken in advancing the art of starting alternating current motors.

The Electric Controller and Manufacturing Company, Cleveland, O., have placed on the market their type ZK Manual Automatic Compensator.

This compensator disposes of the objectional features of the so-called "Hand Compensator," and at the same time has all the good points except remote control, of the Automatic Compensator.

Prior to the introduction of this compensator there have been on the market two means of starting a motor where compensators are necessary. One has been the so-called "Hand Compensator" and the other has been the push button operated automatic compensator.

With the hand compensator it is necessary for the operator to throw a handle to one position and hold it there until he

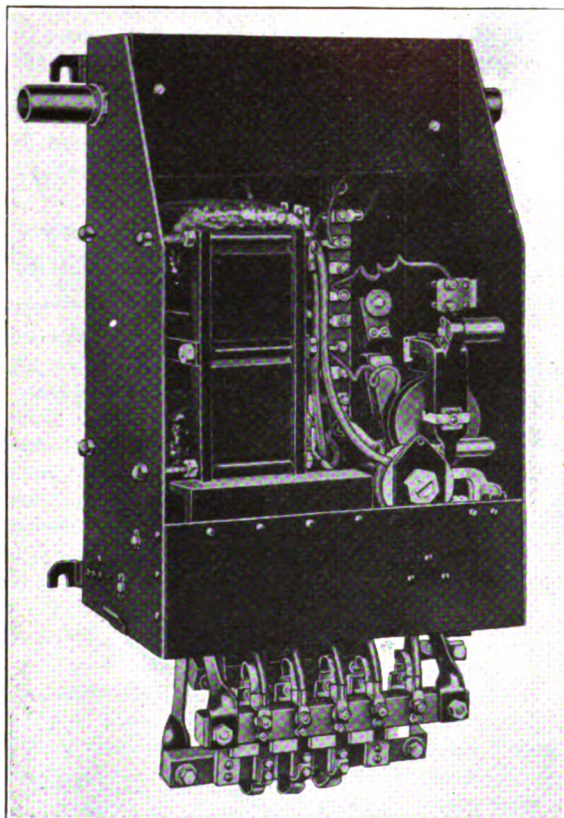
ing" position to the "running" position.

This means that the operator can start the motor with this Manual Automatic Compensator just as easily as throwing a knife switch, and the motor will be protected at all times. The most ignorant laborer can start a motor with this compensator.

Mounted at the top of the compensator there is a panel with inverse time element overload protection, obtained by means of expansion wire overload device.

No voltage protection is also supplied so that in case of overload or failure of voltage, it is necessary to go back to the compensator and throw the handle to again start the motor.

Summing up the Type ZK Manual Automatic Compensator: It automatically accelerates the motor without danger to the motor or to the driven machinery. In case of overload, the motor is protected. In case of voltage failure, the motor is protected and, in case of single phasing, the motor is protected.



thinks the motor has reached sufficient speed that it can be thrown directly across the line.

If the operator throws the handle too quickly from the "starting" position to the "running" position, there is a resultant overload on the motor and a mechanical shock to the machine driven.

With the Type ZK Manual Automatic Compensator, the operator simply throws the handle to the "starting" position and then leaves it alone.

By throwing this handle the motor is connected through the transformers in the compensator to the line, and after the motor has accelerated to a mechanism in the compensator, which automatically throws the compensator from the "start-

Kulp Theft-proof Electric Bulb

The new Kulp Theft-Proof Bulb, designed to prevent all such loss and danger, is just being placed on the market by Lester Kulp, 143 W. Austin avenue, Chicago. The remarkable simplicity of the idea particularly recommends it, as there are no guards, locks, keys, springs, or other mechanisms. It is a standard lamp in every way, that fits into any standard socket—complete in itself and looks and is used exactly the same as any ordinary lamp. And more important still, it carries no extra cost for theft protection, for it is planned to sell this bulb at regular standard prices.

Our contact is at the top, just as in an ordinary lamp. The other contact is a brass ring, fastened at the bottom of a porcelain plug. This plug has a groove which is filled with plaster of paris, lightly holding the brass shell in place. After the lamp is screwed into the socket, an extra turn breaks the plaster of paris seal, so that the lamp can turn freely in the shell, always maintaining electrical contact. The shell, however, cannot be turned in the socket. The shell being spun over the ring, screws up so close to the socket that fingers or tools cannot grasp it. Thus the lamp positively cannot be stolen or even broken in the attempt to steal it, thus preventing endangering circuits.

When the bulb is burned out, it can be easily removed for replacement. The bulbs come in any standard size, voltage or wattage.

The cleaning of the production of the Electrified Foundry, the biggest feature of this exposition, will be by means of sand-blast equipment, manufactured by the Pangborn Corporation, Hagerstown, Md.

They will have in continuous practical operation complete Barrel Sand-Blast and Hygienic Cabinet Sand-Blast installations.

In addition they will have a full display of photographs of different applications of sand-blast equipment, specimens of interesting castings, literature, and data and information available on the use of the metallic abrasives, Angular Steel Grit and Samson Steel Shot at their booths 67 and 68. The booths, which are across the aisle from the Electrified Foundry, will be furnished with a number of easy chairs for the convenience and comfort of visitors.

Mr. John C. Pangborn, vice president; Mr. H. D. Gates, sales manager, and Mr. Jesse J. Bowen, district sales engineer.

Some Pointers on By-Product Coke Oven Operations

"Comparative Tests of By-Product Coke, etc.," a concise booklet of 21 pages with tables, is one of a series published by the Bureau of Mines for the purpose of disseminating information regarding the fuels best adapted for heating houses. A knowledge of the value of the different available fuels helps the householder to select the one that will heat his house at the lowest cost and with the least waste. Such fuel should be clean and smokeless, and should keep the house at an even temperature, with little attention to the fire. Anthracite suitably sized possesses these properties to a large degree and has been used for this purpose for a long time, particularly near the anthracite mines. Many thickly populated districts are so far from these mines, however, that anthracite can be obtained only at a high price, and the bituminous coal that is available is smoky and does not usually maintain a uniform temperature without frequent attention to the fire. By-product coke, in small sizes, is a good substitute for anthracite. It is clean, burns without smoke, and gives a uniform heat. As it is made from bituminous coal, and the bituminous coal beds are very extensive, it seems possible to provide smokeless fuel in the form of by-product coke for practically the entire country.

The Bureau of Mine has issued several publications on the combustion of coal at low rates, in boilers and furnaces: This paper gives the result of tests that were made to compare by-product coke, bituminous coal and anthracite as fuels for small boilers.

An interesting exhibit of industrial control machinery, including its M. D. motor and control, will be shown by the General Electric Company at the convention of the Association of Iron and Steel Electrical Engineers at Buffalo, starting September 24. Engineers of the company from Pittsburgh, Youngstown, Chicago, St. Louis, Detroit, Buffalo, Cleveland, Cincinnati, Philadelphia, Baltimore, Birmingham and Schenectady will be in attendance.

August issue of this magazine published excerpts from the paper by Katz and Bouiquin of the Bureau of Mines, under title of "Comparison of Gas Masks, Hose Masks and Oxygen Breathing Apparatus."

The authors suggest the following modifications, in the interest of safety:

Subject: "Comparison of Gas Masks, Hose Masks and Oxygen Breathing Apparatus."

The second paragraph in the second column under the section headed "Gas Masks" should read:

"Gas masks with canisters containing 600 cc. or more of activated charcoal protect against low concentrations of organic vapors such as aniline, benzene, ether, toluene, gasoline and the like (average 2 per cent in air). The time of concentration decreases rapidly as the concentration increases. Canisters containing gas absorbents other than activated charcoal are useless against these gases."

The fourth paragraph under the same heading should read:

"Gas masks with canisters containing 600 cc. or more of soda lime or caustic soda fused on pumice granules protect against low concentrations of acid gases, such as chlorine, formic acid, hydrogen chloride, hydrogen sulphide, nitrogen peroxide, sulphur dioxide and the like (average 1 per cent in air)."

A concluding paragraph under the section on gas masks should be added thus:

"Canisters containing two or more of the above mentioned absorbents protect against more than one gas or classes of gas, but the total concentration of mixed irrespirable gases in air should not exceed that allowed by the lowest maximum figure for any of the classes included. If more than one adsorbent is contained in a canister the action of each is usually independent of the others and its capacity depends upon its volume, thus the capacity of the canisters containing a mixture of the adsorbents is less for a single gas than that of the canister filled only with the suitable adsorbent."

A loss of \$200,000 to \$250,000 was caused by fire at the benzol plant of the Milwaukee Coke and Gas Company, Milwaukee, Wis., recently. The buildings, tanks and other structures were badly damaged. It is understood a new benzol plant will be constructed as soon as plans are made. The gas and coke departments of the company's plant were only slightly damaged by the fire and operations were not interrupted.

The American Hardware Corporation of New Britain, Conn., has purchased four Westinghouse new model multiple re-tort underfeed stokers and four 500 hp Bigelow boilers. The stoking units include the Westinghouse non-clinking extension sidewall tuyeres and steam-operated dumping mechanisms. The stokers will be driven by Westinghouse motors while the two fans will be operat-

ed one with a Westinghouse turbine and the other with a Westinghouse three-phase motor. The stokers will be driven by steam turbines. These new steam units will use eastern bituminous coal of about 14,000 Btu.

The American Electric Power Company has purchased for their Kenova, W. Va., plant of the Consolidated Light, Heat Power Company, four complete electric stoker driving units. Each is composed of a Westinghouse 7½ hp., three-phase motor with dust proof bearings, drum controller and resistors for varying speed operation from one-half to full speed, primary switch with over-load and low voltage protection and a variable speed transmission with four speeds forward and one speed reverse. This Westinghouse stoker installation will also be equipped with five 50 hp. Westinghouse three-phase motors connected to fans supplying forced draft for the stoker. The electric fan equipment includes starting switches with overload and low voltage protection, auto transformers, and operating panels with ammeters.

P. C. Shea, formerly vice-president and active manager of the P. J. Brown Construction Company, associated with E. G. Whelpley, formerly general superintendent of above company, have organized the Shea-Whelpley Construction Company, specializing in blast furnace, open hearth, and steel plant masonry construction with offices at 407 National Bldg., Cleveland.

OPEN HEARTH

(Continued from page 508.)

York, has become associated with the Heine Company as manager of its New York office, 11 Broadway, while J. R. Fortune, formerly manager of the Heine company's Detroit office has assumed charge of the territories heretofore covered by the Pittsburgh, Cleveland, and Detroit offices. He will maintain offices in the Dime Bank Building, Detroit, and in the Park Building, Pittsburgh. The Cleveland office has been discontinued.

William E. Clark, who has been placed in charge of the Michigan and Northern Ohio territory for the Calorizing Company, Pittsburgh, with offices in the General Motors Building, Detroit, is a graduate of the Crane Technical School, Armour Institute of Technology, and the United States School for Engineer Officers. He formerly was employed in the mechanical department of the American Steel Foundries, Chicago; the American Foundry & Machinery Company, Chicago.

NEWS OF THE PLANTS

The Detroit Steel Corporation, Detroit, Mich., has construction in progress on its new plant at Oakwood, near Detroit, to be used primarily for the production of strip steel. Plans have been filed for the main building, comprising a one-story structure, to cost approximately \$175,000, and superstructure work will be pushed. It is proposed to have the plant ready for operation early in October. It will represent an investment of close to \$350,000, including machinery. W. C. Schrag is president.

The Calumet Steel Company, 208 South LaSalle Street, Chicago, Ill., has completed plans for the construction of a new building at its Chicago Heights plant, to be one-story, 75 x 350 ft., estimated to cost close to \$100,000. Arrangements will be made for the equipment installation at an early date. J. H. Porter is president.

The Walsh & McGee Steel Company, Newark, N. J., is completing the construction of a new rolling mill on Doremus Avenue, and plans to have the structure in service at an early date. The plant will specialize in the production of small rolled bars, and will develop an initial output of about 500 tons per month. It is purposed to advance this capacity to about 600 tons monthly, at an early date. The new mill will be fully equipped in all departments, including a complete heating furnace unit. Harry L. McGee and Phillip C. Walsh, III, head the organization.

The Texas Steel Company, Fort Worth, Tex., recently organized with a capital of \$5,000,000, has commenced work at the former local plant of George W. Armstrong & Company, and will convert a portion of the mills for the production of billet steel bars and other steel products. Electric furnaces will be used for production, with new 8, 10 and 16-inch rolling mills. The company also purposes to manufacture steel bars for concrete reinforcement, small structural shapes and kindred products. John H. Kirby is president.

The Temple Furnace Company, New York, N. Y., recently organized, has resumed operations at the Temple furnaces, Temple, Pa., lately acquired from the Seaboard Steel & Manganese Corporation. One stack will be maintained in active service, while plans are being considered for the blowing in of the second stack in the near future. The new company purposes to develop maximum capacity at the plant, which has been idle for about 36 months past. Nils Andersor is president of the company; S. G. Valen-

tine, formerly connected with the Empire Steel & Iron Company, Oxford, N. J., will act as superintendent.

The Cambridge Steel Company, Cambridge, Ohio, has preliminary plans under advisement for the construction of an addition to its plant, to be one-story, 100 x 100 ft., estimated to cost approximately \$25,000, exclusive of equipment. William Rigby, one of the heads of the company, is in charge.

The Youngstown Sheet & Tube Company, Youngstown, Ohio, has disposed of a bond issue of \$40,000,000, of which approximately \$33,000,000, will be used in connection with the purchase of the Steel & Tube Company of America, recently arranged and the remainder of the fund employed for additions in working capital, as well as proposed extensions and improvements.

R. C. Demarest, head of the Hicks Iron Works, San Francisco, Cal., and the Angels Iron Works, Angels Camp, Cal., is perfecting plans for the organization of a new company to construct and operate an iron smelting and producing plant at Sacramento, to run under the Driscoll process. The initial plant will be of experimental character with a 10-ton furnace installation. With auxiliary equipment, the plant will cost about \$100,000. The Sacramento, Cal., Chamber of Commerce is interested in the project, and closely following initial production, it is purposed to raise a fund of about \$2,000,000 for the construction of a large iron-producing plant under the Driscoll patents. This works will consist of a number of plant units to be operated by Mr. Demarest and associates.

The Mesabi Iron Company, 25 Broad Street, New York, N. Y., has preliminary plans under way for extensions and improvements at its plant. One of the primary features of expansion will be an extension to the present sintering plant, to develop a maximum capacity of 800 tons per day. The plant has a present output of 250 tons daily, and this is now being advanced to 400 tons. To provide for the construction and other expansion, the company will dispose of a stock issue of \$1,570,000.

The Maryland Steel Rolling Company, Fidelity Building, Baltimore, Md., operating a plant at Trenton, N. J., acquired a number of months ago, has purchased Baltimore property and plans for the immediate establishment of a new rolling mill, carrying out a project planned some time ago and held in temporary abeyance. The

new plant will specialize in the manufacture of iron and steel bars, varying from $\frac{3}{8}$ -in. to 2 in. in diameter, as well as bars for concrete reinforcement and other service. It is proposed to provide equipment for a capacity of about 5,000 tons per month. The Trenton plant will be continued in operation.

In connection with its general expansion plans the Wheeling Steel Corporation, Wheeling, W. Va., is considering a new bond issue of \$75,000,000, of which fund, about \$65,000,000 will be used for future development work, including plant additions and improvements, and the installation of additional machinery, over a period of a number of months. The fund will be held in reserve until plans for initial work are consummated.

The Jones & Laughlin Steel Corporation, Pittsburgh, Pa., has preliminary plans under consideration for the construction of additions to its works on South Thirty-fourth Street, near the Monongahela River, including a new bar mill. Negotiations are under way with the local council for vacating property held by the city at this location, to be used as the new mill site.

The Albion Malleable Iron Company, Albion, Mich., has perfected plans for the installation for additional equipment at its plant, for increased operations, comprising a pulverized coal installation with automatic control equipment, etc., conveying machinery, multiple-tube dryers, and auxiliary operating apparatus.

The Columbia Steel Corporation, San Francisco, Cal., operating a plant at Pittsburgh, Cal., has acquired a large tract of land in the vicinity of this plant for a consideration of approximately \$75,000, and purposes to use the site for expansion at the mill. The project will be carried out in connection with other company extensions previously announced, and it is expected to have plans ready at an early date.

The Dominion Alloy Steel Corporation, Sarnia, Ont., is perfecting plans for the construction of the first unit of its proposed new local plant for the manufacture of steel and alloy steel products. The mill will be equipped for an initial capacity of about 40,000 tons per annum, designed to give employment to approximately 500 men. The company is arranging for a stock issue of \$1,000,000, the proceeds to be used for the new plant construction, including machinery purchases. A large part of the plant output will be used by automobile manufacturers.

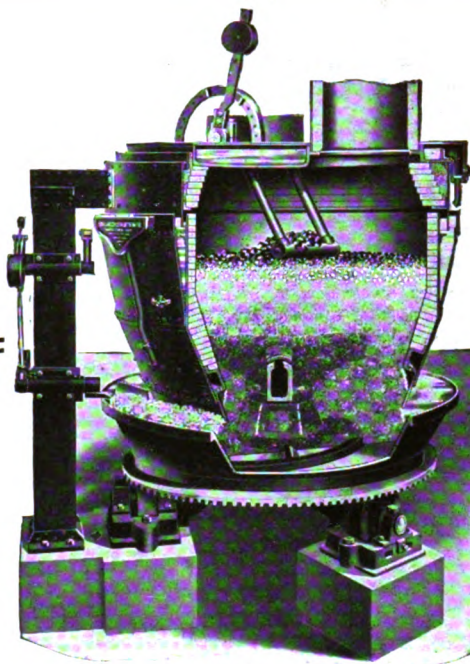
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